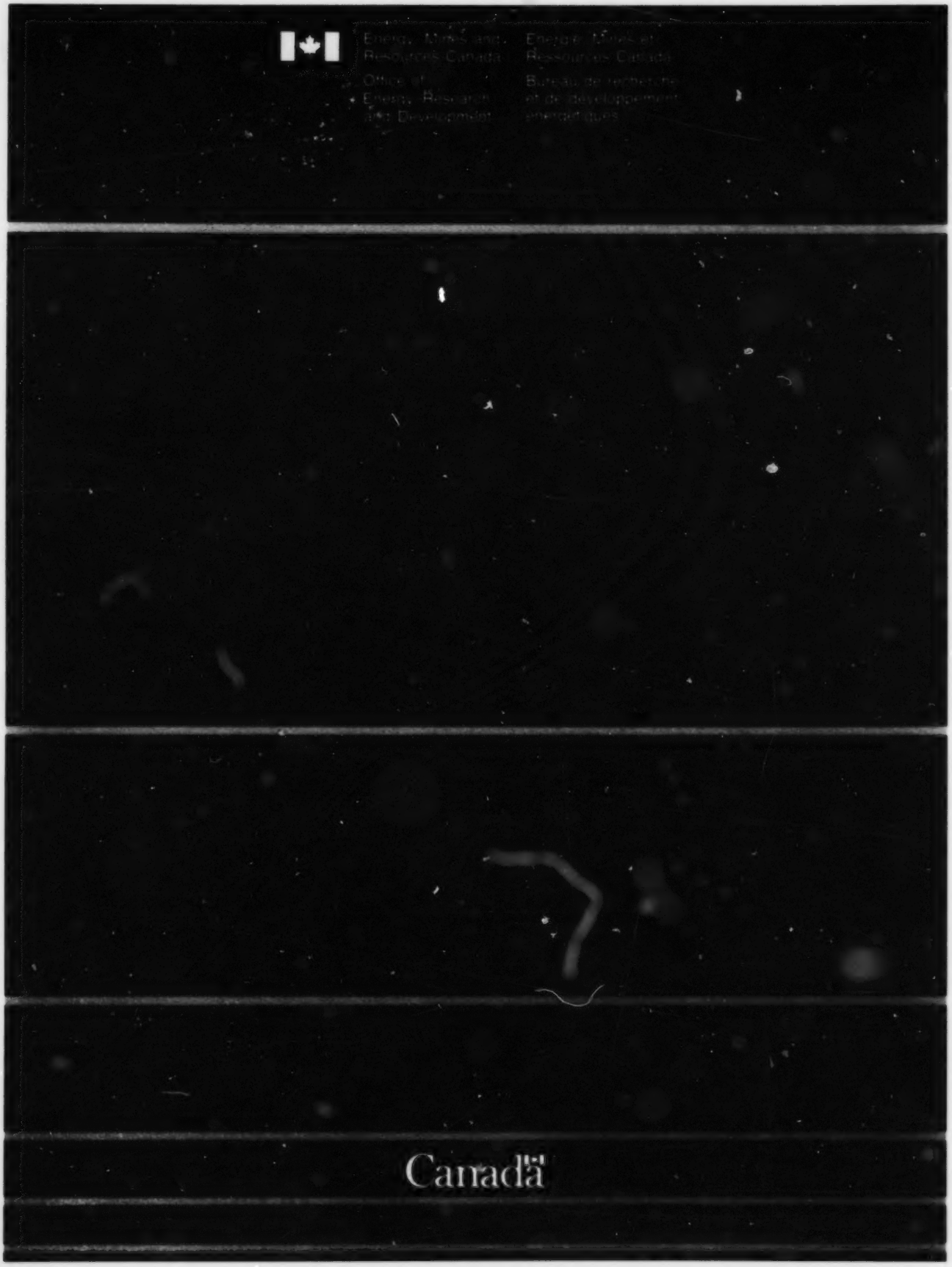
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Canada

A SUMMARY OF ARA CONSULTING GROUP'S EVALUATION OF THE FEDERAL INTERDEPARTMENTAL PROGRAM OF ENERGY RESEARCH AND DEVELOPMENT (PERD)

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This report summarizes the results of the extensive evaluation of PERD, which was initiated by the Panel at its 55th meeting on March 16, 1990, and conducted by ARA Consulting Group over the period May, 1990, through April, 1991. The evaluation was preceded by an assessment study which specified the issues that should be addressed in the evaluation and outlined the plan for carrying out the evaluation. Both the evaluation study and the evaluation assessment were overseen and directed by an interdepartmental Program Evaluation Working Group, consisting of representatives of central agencies and representatives of the departments most active in PERD. The main focus of the evaluation was on the operation of the Program over the five year period 1985/86 through 1989/90.

This report was prepared to inform readers, in a concise manner, of the results of this evaluation and to present the Panel's response to the recommendations contained in the overall evaluation document.

The main issues addressed in the evaluation were:

- *To what extent is there a continuing need for PERD? i.e., to what extent is the rationale for PERD still valid?*
- *To what extent is the focus and balance of PERD appropriate in light of government objectives and market considerations?*
- *To what extent is the R&D carried out under PERD incremental and complementary to R&D being undertaken elsewhere?*
- *How effective is the current delivery process for PERD? Are there ways in which it might be modified (or are there alternate methods of delivery) which might make PERD more effective?*
- *What has been accomplished by PERD: what have been the most important impacts, and what have been the benefits?*
- *To what extent have other parties been involved in paying for and/or carrying out R&D that has been at least partially sponsored by PERD, and to what extent is this level of involvement of other parties optimal?*
- *Are there parts of PERD which should receive either decreased or increased effort and resources*

Over the next year, the Panel will be acting on the recommendations from the evaluation. For a complete response to the recommendations, see Annex A of this document.

EVALUATION SUMMARY

1.0 OVERVIEW OF PERD

The federal Program of Energy Research and Development (PERD) is an interdepartmental program that deals with all aspects of energy research and development except nuclear fission (which is the responsibility of Atomic Energy of Canada Ltd.). The objective of PERD is: "to provide the science and technology for a diversified, economically and environmentally sustainable energy economy". PERD is divided into 7 Tasks:

Task 1: Energy Efficiency
Task 2: Coal
Task 3: Fusion
Task 4: Renewable Energy & Generic Environment
Task 5: Alternative Transportation Fuels
Task 6: Oil, Gas and Electricity
Task 7: Coordination and International Participation.

The Program is coordinated by the Panel on Energy Research and Development (the Panel). The Panel is composed of senior representatives (ADM level) of science and technology branches of the twelve departments and agencies that participate in the Program, together with representatives of the National Research Council and five central agencies. It is chaired by the Assistant Deputy Minister of Mineral and Energy Technology Sector of Energy, Mines and Resources (EMR), and it reports to the Minister of EMR, who in turn reports to Cabinet. The Panel has the formal responsibility for coordinating and implementing PERD. It meets a minimum of twice a year -- to plan strategy and review directions of PERD and to formally approve the multi-year operating plans of the various Tasks and their programs.

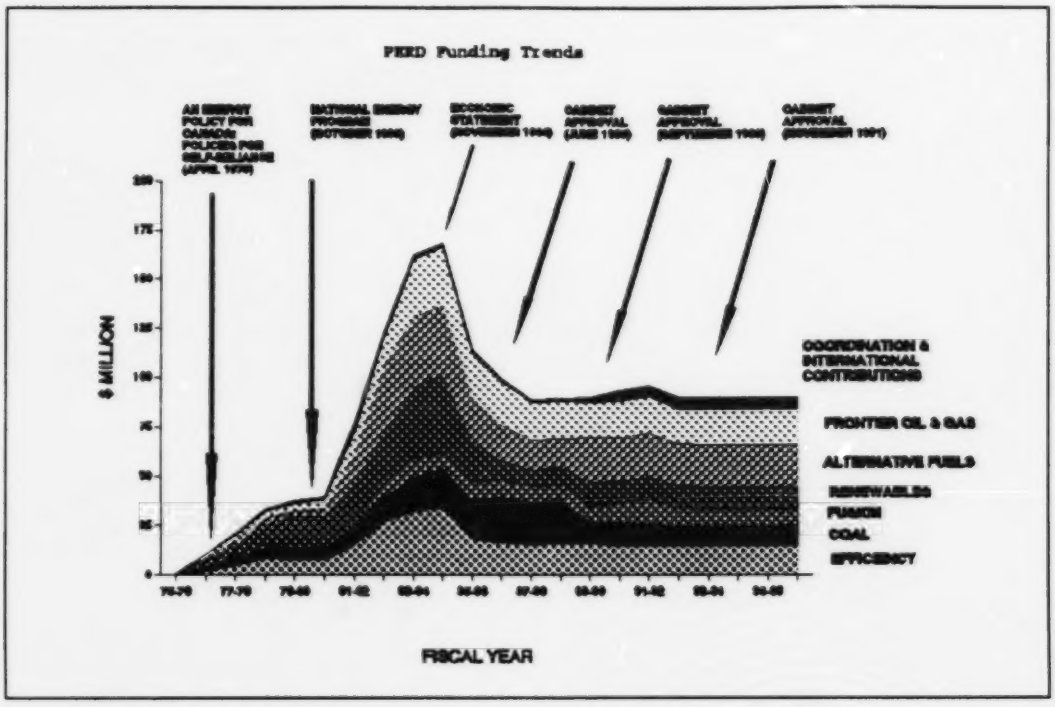
The Office of Energy Research and Development (OERD) acts as the Secretariat to the Panel and is responsible for providing the necessary analyses and advice to the Panel to enable it to fulfil its role. This includes providing advice on new opportunities, strategy, and priorities in the light of changing energy policy objectives and changes in the national and international situation, and information on the status of Canadian and international energy R&D. OERD also manages and administers the operation of the program committees, as well as the general Program activities.

PERD operates with some unique features not common to government programs. First, it includes detailed interdepartmental consultation at the technical/planning level. Second, the Panel has the freedom to make allocations, to some extent, independently of the departments and Treasury Board. Third, because of the technical review process, departmental allocations can change from year to year.

1.1 PROGRAM FUNDING

The budget history of PERD is marked by huge increases following the introduction of the National Energy Program in 1980, from about $40,000,000 per year to a peak of about $170,000,000 in 1984 (Figure 1). PERD's budget was then reduced significantly in late 1984 and 1985 as a result of the government's deficit reduction program.

FIGURE 1



More significantly, the National Research Council's portion of PERD's budget was eliminated and not reallocated to other departments. This obviously had a major impact on the R&D subject areas that were the responsibility of NRC -- e.g., conservation, hydrogen, renewable energy, and fusion. These activities were subsequently sustained at minimum viable levels from PERD budgets of EMR and AECL. Since April, 1989, the budget of PERD has been stabilized at about $90 million per year.

As noted, PERD is an interdepartmental program -- i.e., the funding and the responsibility for carrying out specific research projects are allocated among different government departments. The allocation of program funding by department is outlined below.

Table 1

Distribution of PERD Program Funds by Department (1988-89 $)

Department	$ Million	% of Total
Energy, Mines and Resources	55.4	62.2
Atomic Energy of Canada Limited	8.6	9.7
Environment Canada	7.1	8.0
Fisheries and Oceans	6.7	7.5
Transport Canada	5.0	5.6
Agriculture Canada	2.7	3.0
Public Works Canada	1.3	1.5
Health and Welfare Canada	0.8	0.9
Indian and Northern Affairs	0.7	0.8
Canada Mortgage and Housing Corporation	0.4	0.4
Department of National Defense	0.4	0.4
	89.1	**100.0**

Much of the R&D work within PERD is performed in federal laboratories -- the CANMET Laboratories, the Transportation Development Centre of Transport Canada, the research laboratories of Environment Canada, and so on. A number of the R&D activities are cost-shared with industry, and some of the activities are carried out totally by industry and universities on a contract basis. R&D activities span the spectrum from longer term research (e.g., work on fusion) to developmental work associated with near term commercial applications (e.g., work on the fluidized bed combustion of coal). Some research projects also deal with the development of standards and regulations (e.g., standards and regulations for propane vehicle conversions and fuelling).

1.2 Program Objectives

The OPEC oil embargo of 1974 led to major concerns in western nations regarding security of energy supply. Within Canada it was recognized that research and development could help lead to increased security of supply. Cabinet established a task force of Deputy Ministers on Energy R&D to review the situation and recommend what needed to be done. The objectives of the task force as defined by Cabinet were to:

- review federal energy R&D activities;
- develop and implement a coordinated federal program on energy R&D;
- advise Treasury Board on the allocation of funds for energy R&D;
- coordinate energy R&D activities in the federal government, including the federal approach to major international and federal-provincial initiatives; and
- provide for the exchange of information on energy policy and strategies which would affect the direction of federal energy R&D programs.

The task force evolved into a committee of assistant deputy ministers from the same departments, which was subsequently designated as the Panel on Energy R&D in a 1975-76 Cabinet Memorandum. That memorandum effectively established PERD.

The original program rationale was based on the need to carry out additional R&D -- over and above what the government and other parties (industry, universities) were already carrying out -- in order to increase Canada's security of energy supply. PERD was focused on energy conservation and on the identification and exploitation of alternative energy supplies that would increase security of supply. It should be remembered that, at this time, there was a tremendous sense of the urgent need to obtain self-sufficiency in energy underlying government policies.

Between 1976 and 1979, the main emphasis of PERD was on energy conservation and renewable energy technologies, although some work on coal and oilsands was carried out during this period. Following the OPEC oil price shock of 1980, the Canadian government established the National Energy Program (NEP). In keeping with the objectives of the NEP, Tasks 5 and 6 were added to PERD. Task 5 was added because it was recognized that is was necessary to do more research on alternative transportation fuels if, in the long run, Canada's dependence on oil in the transportation sector was to be reduced. The establishment of Task 6 followed the specification in the NEP of increased federal government involvement in the development of offshore and arctic hydrocarbon resources.

In the early 1980s PERD had the four principal objectives of:

- using energy efficiently, particularly oil;
- developing indigenous resources;
- diversifying the energy economy to be less reliant on oil; and
- developing long term alternative energy sources.

The driving force behind PERD continued to be an overriding concern about energy security.

During the period 1984 and 1985 there was less emphasis on the security of supply rationale for PERD and more emphasis on economic growth and regional development. There was also during this period increasing concern about the adverse environmental impacts of current energy usage patterns -- in particular, concerns about acid rain, tropospheric ozone (smog), and the greenhouse effect. These concerns were also reflected in the rationale and objectives for PERD at that time. Security of supply, however, continued to form part of rationale.

The formal objectives of PERD over the period 1985-87 reflected these concerns; ie.,

- to sustain future energy security;
- to diversify the energy economy;
- to develop and use energy technologies which respect the environment; and
- to sustain the trade and regional development benefits provided by the energy endowment of Canada.

In September, 1988, PERD was extended by Cabinet for another three years (i.e., through fiscal 1991/92), with approval in principle for one additional year after that. The objectives of PERD were not substantially changed.

There are two other external factors that have a significant effect on PERD:

- The federal government policy environment regarding in-house science and technology activity has changed considerably over the past few years. In particular, there is greatly increased emphasis on carrying out applied research with fairly near-term applications that is of interest to Canadian industry. Government laboratories have generally been forced to be more 'business-oriented' -- i.e., develop closer links with industry, increase the amount of cost recovery for R&D carried out in the labs, increase the amount of leverage of government funding, and so on.

- Most of the 'delivery mechanisms' for the R&D carried out under PERD -- e.g. demonstration projects, incentive programs -- have now been phased out. (These were not part of PERD, but were used in conjunction with PERD.) This has presented a new challenge for PERD, namely, how to get the R&D to the user. The main measure that research managers within PERD appear to have adopted is to try to carry out more research projects in direct collaboration with the users.

For the purposes of program evaluation it is desirable to have objectives that are more concrete. Through the interview process carried out during the evaluation assessment study the following objectives were identified as the primary (implicit) operational objectives for

PERD at the present time and were endorsed by the Program Evaluation Working Group.

1. To increase Canada's security of energy supply through increased energy efficiency and increased identification and exploitation of both conventional and non-conventional energy supplies.

2. To act as a stimulus to economic growth, regional development, and increased industrial efficiency and competitiveness.

3. To provide the necessary R&D and R&D capability to enable the government to fulfil its energy policy and regulatory responsibilities.

4. To ensure that the exploitation and use of future energy forms respect the environment (both in terms of maintaining and improving environmental quality).

2.0 STUDY DESIGN

The workplan for the PERD Evaluation was based on the evaluation assessment and the project proposal accepted by the Program Evaluation Working Group. It involved the refinement of the methodological details for the remainder of the study -- development of questionnaires, specification of sampling strategies, and interview procedures.

Collection of Project Data

The main data collection activities were:

- collection of basic information on 451 PERD-supported projects. The information collected included a description of the project objectives, the work carried out, and the main accomplishments, together with information on PERD project resources and in addition (total) funding (e.g., PERD funds + Departmental funds + funding from private firms + funds from other sources) and data on the amount of contracting out and cost recovery.

- an extensive analysis of PERD delivery process, including detailed case studies describing the delivery process for 13 PERD programs. A total of 96 interviews were conducted in the process of carrying out these case studies.

- an assessment of the current validity of PERD rationale.

- a "classification exercise" to obtain information regarding the focus and balance of PERD with regard to: the objectives toward which it was primarily oriented,

secondarily oriented, and so on; the primary intended users; the term of the research (near, medium, or long-term); the orientation toward production of energy, transportation of energy, use of energy, or energy efficiency; and the type of energy on which the R&D was focused.

- interviews with 62 research managers of PERD-supported projects regarding incrementality (the extent to which PERD funds would have been supplied by some other party if PERD had not existed), complementarity (the extent to which the research does not duplicate other research), and the involvement of other parties in either paying for or carrying out the research.

- a survey of 360 people regarding the usefulness and importance of PERD-supported R&D.

- an analysis of the contribution of PERD to increased security of energy supply.

- an analysis of the contribution of PERD to increased environmental protection associated with energy exploitation and use.

- a "modified peer review" exercise to evaluate the importance of Canadian fusion research. In this exercise senior scientists and managers of other fusion research programs and advisory groups around the world who serve on the advisory committees of the two main fusion projects comprising the Canadian Fusion Program were asked to evaluate the importance of the research in light of the world fusion effort.

- the preparation of 21 case studies of PERD projects or groups of projects, each of which was intended to illustrate: major contributions of PERD projects to increased security of energy supply; the role of PERD in supporting the government's policy making and regulatory responsibilities; high impact industrial applications of PERD supported R&D; major contributions of PERD projects to environmental protection.

- interviews of 36 industry officials and sector experts. The industry officials were senior representatives of the various sectors of the energy industry who are knowledgeable about PERD and its importance for their particular industry sector. The sector experts were people with an in-depth knowledge of each of the main energy sectors who have an up-to-date understanding of the priorities within each industry sector and how decisions are made.

- interviews of officials of the main departments involved in PERD regarding the influence of PERD on their department's R&D program.

- a review of Canada's participation in the R&D program of the International Energy Agency.

- a review of PERD's role in the R&D program of the Canadian Electrical Association.

- a workshop with outside experts in energy R&D regarding the appropriateness of the focus and balance of PERD efforts.

3.0 PROGRAM RATIONALE

Issues

Within this component, the evaluation addressed the question of whether the rationale for PERD remained valid. This question was broken down into the following questions:

1. Can the PERD programs reasonably be expected to contribute to current federal government policy goals?

2. Is the R&D being carried out in ways that are consistent with current federal government science policies?

3. Is it appropriate for federal government funds to be used in support of this R&D?

In assessing the rationale for PERD, the evaluation identified several current federal government policies to which the Program is intended to respond. These are:

Economic Development (EP1). The aim of this policy is to promote the expansion of investment and employment within Canada's energy industry, while at the same time ensuring the most efficient allocation of both private and, where necessary, public resources. Objectives of the policy include:

- increased national and regional industrial development and diversification;
- increased gross domestic product; and
- increased competitiveness.

Security of Supply (EP2). This policy relates both to physical supplies and price shocks. Although the policy applies to all energy forms, the risk of supply disruption and price volatility is highest with respect to oil. The security of supply policy implies the desirability of promoting and enhancing a diversity of energy supplies and maintaining economic conditions that stimulate investment in the continuing development of domestic supplies and their efficient use by consumers, to reduce

Canada's net oil import situation and thus our overall vulnerability to a disruption.

National Unity (EP3). This policy is intended to support the federal government's goal of national reconciliation by ensuring balanced and equitable regional development through energy agreements with the provinces and an ongoing process of consultation with energy producers and consumers aimed at producing a consensus between different groups and regions.

Environment (EP4). An important objective of current Canadian energy policy is to ensure that energy production, transportation, transformation, and use occur in a way that minimizes the adverse impact upon the natural environment. It supports the management and conservation of resources which are environmentally sensitive. It also seeks to keep all energy options open by promoting a greater diversity of supply, including both conventional and non-conventional forms of energy.

Canadianization (EP5). This policy seeks to create opportunities for Canadian firms in both the supply and utilization of different forms of energy. Where possible, it aims to find market niches for Canadian industry. Energy policy may also support indigenous technology where needs may not be satisfied through the international technology market (e.g., oil sands, ice navigation, and ongoing support of CANDU).

Because of the inter-departmental nature of PERD, many of its programs have dual rationales, relating both to energy and to the mandate of the department or agency concerned. Since PERD is an energy program, however, the analysis of the validity of its rationale is based primarily on the degree of correspondence of its component programs with energy policies EP1 through EP5. These are the policies that relate to the reasons for originating the PERD funding and to its continuing existence.

There are, however, other energy policies related to public health and safety, energy regulations, and the management of the energy resource base, which play a supporting role to the energy policy objectives. These are:

EP(Sup)1	-	Health and safety issues (where the federal government has residual powers in the R&D aspects only).
EP(Sup)2	-	Support for energy regulation functions.
EP(Sup)3	-	Support for stewardship of federal resources (COGLA, GSC, Forestry Canada).
EP(Sup)4	-	Information re resource base.

Each program was assessed as to whether it could be expected to make a significant contribution to one or more of the policy goals EP1 through EP5.

In addition, overall government policies impact on PERD notably:

- **Economic and Regional Development (SP1).** This policy describes some conditions that should prevail when federal government R&D is carried out in support of economic and regional development; e.g., will the R&D actually contribute to economic and regional development -- are there potential markets for the outputs of the R&D effort, and can the technology be acquired or imported at lower cost than developing it.

- **Extramural Performance (SP4).** This policy specifies the conditions under which it is appropriate to have government R&D performed in-house. These include: national security, policy, or regulatory requirements that preclude private sector performance; essential scientific capability and expertise are needed for a department to perform its mission; federal government capability and expertise are required for international participation in the negotiation and implementation of agreements, and the exchange of information; a capability to assess the current state-of-the-art in science and technology, or in support of procurement decisions; the technical facilities and expertise are not available in the private sector, and it would not be of benefit to Canada to foster such a capacity.

Findings

1. For the most part, all of the individual PERD programs in Tasks 1,2,4,5,6 and 7 are supportive of current federal government energy policies, and are therefore valid elements of current federal government energy strategy.

2. There is a high degree of consistency with the two key federal government science policies -- the policies dealing with economic development oriented R&D and with extramural performance.

3. The review of program rationale found no PERD program that does not satisfy the "appropriability criterion", which states that government support for applied industrial R&D is legitimate only if the benefits of the R&D cannot be appropriated by any one firm or concentrated group of firms.

4. Eighty-eight percent of the reviewers in the user survey considered the group of projects they were reviewing as either "very appropriate" or "moderately appropriate" in achieving one or more of the federal policy objectives.

5. The participants in the workshop to assess the validity of the rationale for Task 3, the National Fusion Program (NFP), concluded that the program should definitely continue.

6. The NFP was found to support the current energy policies related to economic development, national unity, and Canadianization. It can be concluded, therefore, that the NFP is a valid element of current federal government energy strategy. (The NFP was not found to support, in a cost-effective manner, energy policies related to security of supply or the environment, mainly because benefits in these areas would probably be as profound if Canada simply bought reactors "off the shelf" once they become available.)

Discussion

One of the classic evaluation issues asks about the rationale for a program. This question usually has two aspects:

- does the program make logical sense (i.e., is it plausible), and
- is it consistent with applicable government policies?

The first question was answered in the affirmative in the evaluation assessment. The second question is dealt with here and essentially corresponds to the three questions (a,b and c) posed above. (While this question is normally answered in the affirmative in program evaluations, that certainly is not always the case.)

One aspect of an R&D program like PERD which must be kept in mind is that it is composed of a large number of research and development projects. It is not a single entity which never changes. It is made up of literally hundreds of projects whose composition changes over time. Because these research and development projects are started for many reasons (e.g., client needs, to aid development of appropriate regulations, to determine the technical feasibility of a process, to save energy, to protect the environment), their completion and subsequent development, or cancellation, can be influenced by many factors including the results of the research itself. For this reason the analysis of rationale needs to be sensitive to the reality of energy related research and development. A project undertaken to save energy may not achieve its original aim but may produce results useful in other areas such as the environment. Projects also have a life-cycle of their own, and so a research effort undertaken to investigate potential energy savings (e.g., Active Solar) may be a certain size at the beginning of the project, be quite a bit smaller as the research produces results, and finally become very modest so that some expertise is maintained.

The important point about this process is that the research results influence what is known, and this knowledge in turn affects policy considerations, which in turn have an impact on rationale. While this situation poses no overwhelming problem for the analysis which follows, it is important to remember that the link between research and development projects and a policy framework is not static, but dynamic, and research results have a direct influence on policy.

4.0 Focus and Balance

Issues

1. To what extent has the past and present R&D been in support of each of the federal policy objectives:

   - Increasing Canada's security of energy supply;
   - Stimulating economic growth, regional development, and increased industrial efficiency and competitiveness;
   - Providing the R&D and R&D capability to enable the government to fulfil its energy policy and regulatory responsibilities; and
   - Ensuring that the exploitation and use of future energy forms respect the environment.

2. What has been the balance between R&D in which the government has been the primary intended user (of the ultimate applied results) and that in which industry has been the primary intended user?

3. What has been the balance among near-term, medium-term, and long-term R&D?

4. What has been the balance among R&D projects related to different types of energy?

5. What has been the balance of R&D projects related to:

   - Production of energy;
   - Transportation of energy;
   - Efficiency of energy usage; and
   - Use of energy in general.

6. To what extent has the focus and balance of PERD effort carried out in the past (as reflected in the answers to questions (1) through (5)) been appropriate in light of government objectives and market considerations at the time?

7. To what extent are the focus and balance of current and planned PERD effort appropriate in light of current and foreseeable government objectives and market considerations?

Findings

The analysis of PERD concluded that, the focus and balance to date and the planned focus and balance are reasonable. It must be recognized, however, that PERD projects may have several objectives, and are undertaken for a variety of policy purposes. Specific findings were:

- About 55% of PERD funding has been directed toward projects whose primary objective is increased energy security. The remainder has been roughly equally directed toward projects which support government responsibilities (e.g., development of regulations) projects directed primarily toward economic development; and projects directed primarily toward environmental protection and enhancement.

- There has been no major variation in these allocations over the five year study period, although there has been a shift in emphasis of the environmental objective: it has recently become a more important primary objective of projects, rather than just a secondary objective of the R&D. The percentage of PERD funding allocated to projects primarily oriented toward environmental enhancement rising from about 10.2% in 1985/86 to 13.4% in 1989/90.

- The proportion of PERD funding directed mainly toward industrial users has remained at about 67% over the years, with 33% directed toward projects in support of government responsibilities.

- About half of the PERD budget has been directed toward near-term R&D, with roughly a third supporting medium-term work and a fifth supporting long-term research.

- Just under half the PERD budget over the past five years has supported R&D into oil and gas topics (including both frontier and oil sands/heavy oil topics), followed by 19% of the budget for renewables, 16% for coal, 10% for fusion, 6% for electricity, and 3% for generic research.

- Projects devoted to the production of conventional and unconventional energy sources have consumed about 60% of the PERD budget over the years; efficiency projects about 20%; other projects dealing with energy usage about 12%; and energy transportation work 8%.

Discussion

The appropriateness of five dimensions of focus and balance were addressed in the study:

a) the balance between industry-oriented and government-oriented research

b) the relative amount of R&D carried out in support of each of the four PERD objectives

c) the balance between near-term and longer-term research

d) the balance between R&D related to the production of energy in comparison to R&D related to the use of energy

e) the balance between R&D based on different energy feedstocks.

Based on the focus and balance of PERD with regard to the first three of these dimensions was generally considered to be good. The focus and balance with regard to the last two was considered to be fair to good, with some indications that consideration should be given to gradual adjustments to the balance of programming on these two dimensions.

5.0 INCREMENTALITY AND COMPLEMENTARITY

Issues

To what extent is the R&D carried out under PERD incremental and complementary to R&D being undertaken elsewhere in the public and private sectors, domestically and internationally? This issue includes two separate questions:

1. To what extent is the R&D carried out under PERD incremental -- i.e., in the absence of PERD to what extent would this R&D be carried out by other parties (and when would this occur)?

2. In what ways does the R&D carried out under PERD complement the R&D being undertaken elsewhere--e.g., by extending the depth and breadth of private sector research, by adapting and extending research results so that they apply to Canadian

conditions, by filling a gap in the international R&D effort, by investigating resources or situations that are unique to Canada, and so on.

Findings

The issue of the incrementality of PERD funding is difficult to grasp. The basic question is whether or not the PERD funding for the R&D projects is subsidizing funds from some other source. For example, if PERD did not exist, would it be the case that industry would step in and supply much of the funding that now comes from PERD? Or, similarly, for government-oriented projects, might PERD funding be supplied by other government departments and agencies in the absence of PERD? The evaluation found that PERD funding is not subsidizing other R&D of parties -- i.e., in technical terms, the PERD funding is highly incremental.

If PERD had not existed, the amount of funding from other (non-PERD) parties for this collection of projects would have been less than it actually has been, and funding for the bulk of PERD supported projects would not have been supplied by some other party.

"Complementarity" is also a technical program evaluation term, but the issue is easier to grasp. One is simply asking whether the R&D supported by PERD is unnecessarily duplicating the R&D carried out by other parties. If it is not, then PERD projects are said to be complementary. This is, in fact, what the evaluation found -- i.e., the extent of complementarity of PERD projects is very high.

Specific findings related to these issues were:

1. For research that supports government responsibilities, the overwhelming response of the research managers interviewed was that, in the absence of PERD the individual departments would not fund this work using their own A-base, because there simply is not enough A-base money available.

2. For research that supports industry goals, the research managers were also of the opinion that PERD funds provide an opportunity to do incremental work. However, in their opinion, even if some of the work would be carried out in the absence of PERD, the Program has a number of other important impacts -- it increases the size and scope of the work, the variety of possible approaches, the pool of expertise available to explore the research, the mechanisms by which R&D can be accomplished and, in the final analysis, the ability to undertake the project at all.

3. Based on the results of the user survey, we estimate that about 20% of PERD-supported projects would have been at least partially carried out if PERD had not existed.

4. We estimate that only about 4% of PERD projects that have been 100% funded by PERD would have been partially carried out if PERD had not existed.

5. The funding associated with PERD projects is highly incremental. Based on user survey data we estimate that about $449 million was spent on PERD projects in the user survey over the period 1985/86-1989/90 that would not have been spent on these projects if PERD had not existed. This is comprised of the PERD budget for these projects, $309 million, plus $140 million spent by other (non-PERD) parties.

6. The extent of complementarity (lack of unnecessary duplication) of PERD projects is very high. All data sources -- research managers, user survey respondents, and industry officials: and sector experts -- were virtually unanimous on this point.

Discussion

Incrementality

It was recognized at the time of the evaluation assessment that it would be extremely difficult and costly to definitively determine the incremental contribution of PERD to each of its key objectives, especially security of supply and environmental protection. Therefore, it was decided to drop back one step and look at the incrementality of PERD-supported projects -- i.e., if PERD had not existed, to what extent would these projects been carried out anyway? Obviously, as a minimum, some of the projects have to be incremental (or at least partially incremental) in order for PERD's effects to be incremental.

Interviews of Research Managers

Before a discussion of the results of the interviews of federal research managers, we should note that they could be less objective regarding the question of incrementality than the other data sources discussed below -- they are recipients of PERD funding for their research, and this funding could theoretically be withdrawn (or reduced) if it were determined that funding for the research is available from other sources. On the other hand, they are probably the most knowledgeable of all our data sources regarding this issue.

Projects in Support of Industry Goals

Thirty-nine respondents (about 63% of the total) indicated their projects were partially or wholly in support of industry goals.

The PERD contribution to their research project as a whole was rated as "very important" by 61 of the 62 project managers. Almost two-thirds of them estimated that little or none of the project work would have been done without PERD money.

While the agreement on the importance of the PERD funds was almost unanimous, there was much more diversity in the project managers' explanations of why this is so. These explanations cover a wide range of topics and offer, among other things, an interesting view of the perceived differences in the ways research and development are approached by government versus industry and the effects of these differences on the research itself. The remainder of this section details the research managers' reasons for believing PERD funding is important and the research is incremental.

In general, A-base was not perceived as a realistic alternative to PERD funding to ensure that those projects would be carried out. In fact, research managers essentially believed there were no equally effective alternatives to PERD money, either from government or industry, even though alternative sources of funding may exist for some of these projects. The reasons for this are explained below.

Breadth and Detail. Of the respondents who felt that at least a little of the work would have been accomplished without the PERD contribution, most remaining managers believed that some or all the work would have been done over a far longer time frame and be more difficult to organize and coordinate. Project managers also stated that the project would be far smaller and lacking in both breadth and detail.

In general PERD was seen as allowing a more "Canada-wide" approach to the work than industry alone, and supporting the development of technologies that no one single company could undertake. For example, one study is quantifying and qualifying coal deposits across the country. If industry were doing the same work, an individual firm would only be comparing the advantages of a few types of coal over another with respect to its own operations.

Goals and Priorities. The differences in the manner in which government and industry approach research and development were cited repeatedly as an explanation as to why industry would not be likely to perform the particular research under discussion, particularly in areas environmental or conservation concerns. Another difference relates to the riskiness of the research (i.e., research that may not result in a useable product.)

Short-term versus Long-term Research. Many managers suggested that the research and development that PERD supports is capable of a much longer-term approach than industry R&D. "Industry would only do the work after the problem occurred"; "Industries are pragmatic, so short term"; and "Industry wouldn't be interested, it's a long-term project", were typical comments by the managers.

Similarly, many of the projects involve research at a very early stage in its development. Thus the benefits to industry are often obscure or, even if visible, far too risky for a company to attempt. PERD relieves them of the risk of trying innovative products. The companies won't test these products without support."

Low Industry Resources. Another major reason cited quite frequently for the inability of industry to do PERD supported R&D was a lack of research resources in industry. Several managers described the industries their work supported as made up of numerous small companies which individually had little or no money for research and development.

In a related issue, it was occasionally mentioned that in industries where a few major companies do exist and do have the research capability, those companies would never share the results with the many other smaller companies that exist. So unless government funds it, those smaller companies would never have access to the information.

Networking, Coordination and Credibility. PERD funded projects play a role in pulling together a wide variety of resources including government departments, industry, academia, and sometimes international agencies and firms. The initial involvement of participants from a variety of arenas across the country was felt by many to enable and facilitate large, closely knit and well coordinated research efforts that would otherwise have been much more difficult -- if not impossible -- to organize.

There is a feeling that the actual organizational arrangement (including the Panel, committee meetings, advisory boards, and so forth) is a great help to the research itself by providing information, resources connections, and an overview of a particular field. Essentially, a very useful networking capability is created through PERD. This networking capability has been greatly assisted by the long-term commitment of PERD, both through the availability of its resources over time and through the multitude of participants willing to work on long-term joint projects.

The presence of PERD funds appears to lend credibility, providing a sort of "federal seal of approval", that encourages firms to cooperate in research they can be certain is relevant and important. PERD also supplies mechanisms for coordinating such an effort.

Projects in Support of Government Responsibilities

If PERD R&D supports government responsibilities, it is of interest to know why the individual departments do not fund this work on their own using A-base resources, especially if the research is important to fulfilling their department mandate.

Forty-three respondents (about 69% of the total) reported that their project would be used by their department wholly or partially for making policies, setting standards, and so forth. About 84% of these people thought that without the research there would be a moderate to major detriment to the department's ability of carry out those tasks effectively. When asked why the department did not use A-base funds to support the work, the overwhelming response from all the project managers was that there was simply not enough A-base money available to fund it. A-base funds were perceived as very limited or non-existent, especially given that they often support PYs, but not other research expenses.

In summary, for research that supports government responsibilities, the overwhelming response of the research managers was that, in the absence of PERD the individual departments would not fund this work using their own A-base resources, because there simply is not enough A-base money available. For research that supports industry goals, the research managers were also of the opinion that PERD funds provide an opportunity to do incremental work. PERD also has a number of other important impacts -- it increases the size and scope of the work, the variety of possible approaches, the pool of expertise available to explore the research, the mechanisms by which R&D can be accomplished and, in the final analysis, the ability to undertake the project at all.

User Survey Results

The basic question we are addressing is: to what extent have additional dollars been spent on PERD-supported R&D projects as a result of PERD? In other words, how much has been spent on these projects that would not have been spent on these projects if PERD had not existed?

As a first step in analyzing incrementality, we look at the number of projects that were specified as likely to have been carried out in the absence of PERD which have been 100% funded by PERD (Table 2). If there are many of these projects, then it is likely that the PERD funding is not very incremental, because all the money that would have been spent on these projects in the absence of PERD subtracts from the incrementality of the PERD funding (i.e., these are the "bad projects" with regard to incrementality).

Table 2

Task	Number of projects 100% PERD funded 85/86-89/90 period	% of Projects in the User Survey (for which we have financial data)
1	9	31%
2	2	6%
4	11	16%
5	15	23%
6	23	15%
Total	**60**	**17%**

Of these 60 projects that were specified as likely to have been at least partly carried out in the absence of PERD, respondents indicated that only about 25% would have been carried out had PERD not existed.

Respondents were then asked to specify the percentage of the work that likely would have been done in this case. For each project that was specified as likely to have existed in the absence of PERD by one or more respondents (these are called specified projects in the remainder of this section), we then calculated the percentage of the work that would have been carried out (in the opinions of the user survey respondents) by averaging the percentages stated for that project, including 0% for those respondents who said they thought the project likely would not have existed in the absence of PERD. Table 3 shows the results of these calculations, based on the budgets for the specified projects for the total study period (1985/86 through 1989/90). Except Task 2, the funding for the specified projects from non-PERD parties would have been less than it actually has been. (The exception in Task 2 is accounted for by respondents' opinions regarding the incrementality of one large project.)

These data were then used to estimate the amount of incremental dollars due to PERD for the total sample of projects in the user survey (for which we have financial data). In order to do this, it is necessary to make an assumption about the projects which no respondents specified as likely to have been at least partially carried out in the absence of PERD. It is reasonable to assume that none of these projects would have existed in the absence of PERD, since for each project, every respondent for the project grouping which contained that project either said the project would not have existed or said "don't know". Based on this assumption,

Table 3

Estimated Amount of Funding Specified Projects Would Have Received Over 1985/86-1989/90 From Non-PERD Parties in the Absence of PERD

Task	Amount Projects Would Have Received From Non-PERD Parties Without PERD ($k)	Amount Projects Actually Received From Non-PERD Parties With PERD ($k)
1	19,323	27,265
2	18,302	8,866
4	27,126	40,139
5	42,834	48,048
6	73,495	77,314
Total	**181,080**	**201,632**

Table 4 shows our calculations of the incremental dollars spent on these projects due to PERD. The table also shows the PERD budget for each Task, and it can be seen that the incremental dollars exceed the PERD budget for every Task. Overall, the incremental dollars exceed the PERD budget by 45%.

Table 4

Estimated Incremental R&D Funds Spent Over 1985/86-1989/90 on User Survey Projects Due to PERD

Task	Incremental Funds ($k)	PERD Budget ($k)	Incremental Funds as a % of PERD Budget
1	52,861	36,232	146%
2	79,196	49,316	161%
4	87,727	57,874	152%
5	99,728	79,762	125%
6	129,346	85,345	152%
Total	**448,858**	**308,529**	**145%**

To help readers better understand the meaning of the number presented in Table 4, we note that the $448,858 K of incremental funds is made up of three components:

$308,529k	=	PERD budget
+ 20,552k	=	For projects that would have existed in the absence of PERD, this is the amount contributed by non-PERD parties to these projects which they would not have contributed to these projects in the absence of PERD (This can be computed from Table 3)
+119,777k	=	For projects that would not have existed in the absence of PERD, this is the amount contributed by non-PERD parties to these projects.
$448,858k	=	Total incremental funding due to PERD.

Because the assumption used in the estimates presented above could be regarded as favourable to the Program, we also calculated a lower bound for the amount of incremental dollars that can be attributed to PERD. This was done by assuming that every project deemed likely to have existed in the absence of PERD would, in fact, have existed and that the non-PERD parties involved in each of these projects would have provided the same amount of funding support for the project as they actually did provide.

Table 5

Lower Bound Estimates of Incremental R&D Funds Spent Over 1985/86-1989/90 on User Survey Projects Due to PERD

Task	Lower Bound Estimate of Incremental Funds ($k)	PERD Budget ($k)	Lower Bound as a % of PERD Budget
1	44,174	36,232	122%
2	39,880	49,316	81%
4	70,887	57,874	122%
5	84,976	79,762	107%
6	89,164	85,345	104%
Total	**329,081**	**308,529**	**107%**

It is clear from the data presented in Table 5, that, at least in the opinions of user survey respondents, the amount of incremental R&D funding due to PERD is quite significant. This is a fairly surprising finding, given the applied nature of PERD and given the focus of the Program on R&D intended to be useful in the relatively near-term to industry and government clients. It shows that, although PERD is supplying funds for research, it is not, on balance, displacing funds that the clients themselves would have spent on this R&D.

Other Data Sources

There are some general data on incrementality from the survey of industry officials and sector experts. Interviewees commenting on industry-oriented programs were asked: "How likely is it that industry would have carried out a significant amount of the research in the specific program [they were commenting on] if PERD had not existed...?"

Most of those interviewees who responded that their industry would not likely have continued to carry out the program's R&D gave the following reasons:

- The industry's priorities differ from those of PERD, so although the program may be important to them, it is not necessarily at the very top of their list.
- The program's R&D is too costly, especially if it is long-term research.
- The industry is too fragmented and could not coordinate its R&D activities.
- The industry doesn't have sufficient technical expertise and specialized facilities.

The interviewees who said that their industry would have continued to carry out a significant amount of the research often qualified their answers with comments such as:

- The emphasis would have been more short-term.
- The research would not have been oriented as much as it was toward environmental, health, and safety issues.
- The research would have focused more on their specific needs and would not have included the generic aspects (e.g., it wouldn't have produced the information needed to develop standards).
- The results of the research would not have been shared with other parties.
- They wouldn't have handled the corollary issues.

The main reasons given by respondents who said a government department was unlikely to have carried out a significant amount of the research were:

- This research is not among the top priorities of the appropriate government department.

- There isn't enough A-base money to carry out a significant amount of this research without PERD support.

These interviews tended to confirm that:

- Some of the firms - but by no means all of the firms - who have participated in funding PERD projects would have carried out some of this research without PERD.

- It is less likely that government departments would have carried out a significant amount of the government-oriented research in the absence of PERD.

- The industry-oriented research that would have been carried out would have been more limited in scope.

Complementarity

Interviews of Research Managers

Complementarity refers to the degree to which the research project's objectives and activities complement and mutually support those of other projects and other research groups, both in Canada and internationally, as opposed to unnecessarily duplicating other research. For example, the results of two complementary projects might be combined to form a complete (or at least more complete) answer to a given puzzle.

While 86% of the project managers were aware of research and development efforts being carried out elsewhere that are similar to PERD work, none of the respondents felt that PERD research unnecessarily duplicated this other work. The most frequent response by far was that PERD work complemented and was done in coordination with other research in the area, both in Canada and internationally.

Managers reported they had regular meetings with these other groups, shared the research, and split up the effort to make PERD R&D complementary. They spoke of sharing information and coordinating the effort so that they used technical information from other R&D, thus saving time, effort and money. (Note that this is, of course, a normal part of the scientific process.)

Another frequently heard explanation of PERD complementarity referred to the scope of the project, in that PERD work extends the depth and/or breadth of research being done elsewhere. Managers made comments such as "nothing approached the precision and accuracy" of their work, or, "PERD supports much larger research, including field, theoretical and lab work. It's all encompassing, not piecemeal."

Often the reason PERD research is complementary appears to be related directly to situations or resources that are unique to Canada (climate, off-shore, regulations). A few project managers said some of the work might not be totally complementary because of the issue of confidentiality; that is, some firms doing similar work would not release the information to the government or the public because of the competitive nature of industry, so it was necessary to duplicate it to get access to the results.

Other Data Sources

The two data sources discussed in this section are the user survey and the interviews of industry officials and sector experts.

In the user survey the reviewers were asked: "Does the specified research program [they were commenting on] complement the R&D being carried out elsewhere in this area ... [as opposed to unnecessarily duplicating other R&D]?"

The results of the interviews of industry officials and sector experts were similar. 97% of the respondents said that the PERD research in the program they were commenting on complemented -- and did not unnecessarily duplicate -- the work being carried out elsewhere.

When asked "how" the reasons checked by more than half the reviewers were:

- Extends the depth and breadth of research done by other Canadian firms or organizations - 74% of reviewers.
- Adapts and extends research results so that they apply to Canadian conditions - 65% of reviewers
- Addresses situations or resources that are unique to Canada - 62% of reviewers.
- Complements other work being done by user organizations - 58% of reviewers.
- Fills a gap in the international R&D effort - 55% of reviewers.

The main reason given by interview respondents for the high level of complementarity was that there is close cooperation with other researchers, even with the U.S. and at the international level. Some people noted that the scarcity of resources for R&D in Canada had a positive impact on complementarity -- with scarce resources it is especially important to avoid unnecessary duplication. It was also stated that any apparent duplication was not really duplication but, in general, R&D similar to other R&D but specific to Canadian conditions (e.g., Arctic), perspectives (e.g., specific environmental concerns), or needs.

6.0 DELIVERY PROCESS

Issues

How effective is the current delivery process (Program structure, organization, and activities) for the Program? Are there ways in which it might be modified (or are there alternate methods of delivery) which might make the Program more effective?

This includes the following questions:

1. How is the Program currently delivered? --ie., how are the Tasks and programs defined, how are priorities identified within Tasks and programs, how does project selection occur, how are resources allocated among Tasks, programs, and departments, and so on?

2. How adequate is the project selection process and are the methods used for ensuring the focus and balance of PERD efforts appropriate?

3. How adequate are the methods that are used for ensuring that the research carried out is of high quality?

4. How adequate are the methods that are used for ensuring that the research is incremental and complementary to research being carried out elsewhere?

5. How adequate are the methods that are used for ensuring that the research is carried out cost-effectively?

6. How adequate are the methods that are used for monitoring the progress of the research?

7. How adequate are the methods that are used for disseminating the research results to intended users and effecting technology transfer?

8. To what extent is the process sufficiently flexible and rational to respond to changing government priorities, external market trends, and internal departmental capacities?

9. Are there ways in which the delivery process should be modified to make it more effective, or are there alternate methods of delivery which might be more effective?

Findings

1. Priorities for a program are set in two ways: broad objectives are set by the Panel and revisited from time to time; committees have formal or informal mechanisms for establishing priorities (e.g., meetings with outside experts, clients, industry associations, formal workshops).

2. Panel priorities are communicated to departments through: the call for proposals, the involvement of coordinators and chairs along with other experts in conferences, and priority-setting workshops.

3. Proposals are generated as follows:

   - Committee members meet with department managers to discuss the priorities set out in the "call for proposals" letters. Department managers then translate the priorities into projects for the scientists.

   - Departments identify research topics through various methods. For example, topics of study are put through a peer review; seminars are held to discuss priorities and gain feedback from the scientists; workshops are held including various interest groups.

   - Scientists respond with proposals assembled as outlined in the Panel guidelines. As well, scientists contact users and use their scientific networks.

4. The proposals are assessed through the following mechanisms:

   - proposals are put through an extensive review process before being presented to the committee;

   - certain criteria are applied to the proposals (e.g., likelihood of success, past performance, leverage, etc); however it is impossible to rank the criteria in any way because the importance of any given criterion changes with the proposal being considered;

- in most cases, a proposal has been thoroughly reviewed by researchers, program managers, other experts, and a committee before it is accepted.

In general, these mechanisms work quite well. However, we have some reservations about the adequacy of the review and selection process for some of the program committees. Essentially, these reservations relate to the extent to which the projects put forward are assessed against the priorities of the Panel, as opposed to the priorities of the proponent agency.

5. Day-to-day project management and the management of intellectual property are the responsibilities of the departments. OERD maintains an overview of the projects and the committees monitor the projects once or twice a year. The methods for monitoring progress are considered to be adequate.

6. A number of effective mechanisms are used to help ensure appropriate focus and balance. These include: workshops, client participation, the use of outside experts, changes in projects or topic areas funded, changes in the structure of programs and Tasks, reviews, advisory committees, and consultations with industry association.

7. Mechanisms in place to assure quality research include: peer review, the specification of deliverables for each project, the use of project results by clients, outside review of projects, the committee process, publication/presentation of results to peers or at special topic conferences and the review of results by outside experts. The delivery process review team concluded that these mechanism are adequate, and this was confirmed in the user survey, in which the quality of the research was very highly rated.

8. The methods used to ensure complementarity of research projects are quite adequate.

9. A number of factors related to the incrementality of projects are generally considered in the project evaluation process -- the added value of the research to the Panel's objectives, the degree of leveraging, and so on. To the extent that committees address these factors, the projects that are approved are more likely to be incremental. The one thing that is missing is a mechanism to ensure that incrementality is always explicitly addressed.

10. The methods for ensuring cost-effectiveness are in place and are adequate.

11. The methods used for disseminating results include: published papers, seminars, workshops, conference presentations, active efforts to transfer results to clients, mailing lists, library deposits, and response to requests for information. The need to

improve the effectiveness of the dissemination process was identified in the delivery process interviews (i.e., are people other than direct clients of the Program able to identify and find research material?). In addition, the dissemination process was rated quite low in the user survey. There appears to be a problem with the degree of awareness of PERD projects by potential user organizations.

12. From the interviews and our review of the delivery process, it is possible to say that the process is sufficiently flexible and rational to respond to changing priorities.

13. There are some modifications to the delivery process that should be considered, but alternative methods of delivery are not attractive. (The alternatives considered were: 1) establishing the Panel as something similar to a granting council; 2) transferring R&D funds permanently to departments and; 3) conducting all work from within one department (presumably EMR).)

Discussion

How are proposals generated?

In response to the annual call for proposals from the Panel, the committee members, within their programs, meet with the department managers to discuss the priorities set out in the call letter. The department managers then translate the priorities into project areas for the researchers.

Each department handles the identification of research topics in a different way. All departments conduct or participate in workshops with various interest groups (e.g., associations, standards groups, industry, research institutes) to identify the priorities of the relative research. The results of such workshops are conveyed to the scientists.

The scientists respond with proposals assembled as outlined in the Panel guidelines. To keep abreast of the priorities themselves, the scientists directly contact users (e.g., fishing industry, oil and gas industry) and use their scientific networks. Some proposals are generated from existing work. Other proposals are generated by scientists from discussions they have with each other.

How are proposals assessed?

Most of those interviewed stressed the point that a project had to be suitable and meet the objectives of the Panel before it would be considered. Generally, a winnowing process occurs in departments, and informally among committee members, before proposals are

presented to the committee. (Fusion is an exception to this, as are programs in which non-government organizations submit proposals, such as IERD and DRECT.)

The assessment process for a proposal varies by program. However, in most cases a proposal has been thoroughly reviewed by researchers, program managers, other experts and a committee before it is accepted. In most cases clients and users have also commented on the proposal.

Most of those interviewed felt the assessment process was appropriate. When prompted, some did say that there could be clearer specification of client and client interest, energy savings, and economic benefits.

How are the projects managed?

The Panel has delegated day-to-day project management, financial management, and the management of intellectual property to the responsible departments. OERD maintains an overview of the projects, and the committees monitor projects once or twice a year.

All those interviewed who are responsible for tracking projects have in place mechanisms (usually automated) for monitoring the progress of individual projects. Because PERD funds are allocated to the A-base of a department, they are subject to the usual accounting and management controls. In addition, OERD has developed, in conjunction with departments, the notion of a specific deliverable (or series of deliverables) for a project. These deliverables are tracked by the committee and form the basis for managing projects. The list of deliverables is formally published each year and is used extensively by the committees and OERD.

What mechanisms are in place to ensure appropriate balance and focus of the programs?

In all cases looked at as part of this review there are a number of mechanisms in place to ensure balance and focus. These mechanisms include: workshops, client participation, the use of outside experts, reviews, advisory committees, and consultations with industry associations.

What mechanisms are in place to ensure the research is of high quality?

Mechanisms mentioned by those interviewed include: peer review, the specification of deliverables for each project, the review of project results by clients, the committee process, publication/presentation of results to peers or at special topic conferences, and the review of results by outside experts. These mechanisms vary by Task, by program and department.

What are the methods used for disseminating results to users/public? How well does this work?

The interviews indicated that the methods used for disseminating results include: published papers, seminars, workshops, conference presentations, active efforts to transfer results to clients, mailing lists, library deposits, and responses to requests for information.

While most of those interviewed were reasonably comfortable with the dissemination of results, they also were curious as to the adequacy of the dissemination. While they felt that the clients directly involved in the Program knew about the results of the work, they wondered if other interested people would be able to identify and find the material. Some wanted a more aggressive distribution and marketing program that would reach a wider audience, including the public. Very few projects have an active promotion and marketing approach (although it should be noted that many projects are quite technical and are aimed at a very limited user group).

The Project Selection Process

Adequacy of the Project Selection Process

In general, we found the project selection process to be quite adequate. Our one reservation is with regard to program committees which we have termed "agency determined".

Observing the committee meetings where projects are agency-determined, it is clear that program committees involved do not do all that one might expect. In the main the committee is presented with a set of projects developed by an agency, and its ability to assess these projects against priorities of the Panel is limited, in part because the agency's projects have been thought through by the agency, and the committee has only those projects to consider. The agency (or department) is of course doing what it should do, but there is no easy way to determine if the projects funded reflect the priorities of the Panel or are the best set of projects to be funded by the Program.

In the view of the study team the problem lies in establishing priorities and in their communication. It is not the case that agency determined projects are not good projects. On the contrary, many of them are good projects and appropriate for meeting the objectives of the Panel. Their appropriateness is not at question. The question is how are Panel priorities established and communicated to agencies and departments. In some cases there are well-established mechanisms and in other areas there is not. Establishing and communicating such priorities should be the responsibility of each program committee.

Methods for Focus and Balance

There is of course no way to establish an "ideal" balance and focus for a research program. The balance and focus will change as research results are made available and changes occur in the external world. Because the world changes, priorities will change, and the most important element in acquiring balance and focus is to have mechanisms in place to respond to changed circumstances.

The mechanisms used in the Panel process include the Task structure itself, the committee structure, the division of work into programs and projects, Task reviews, the existence of workshops which set priorities, and the involvement of clients. The division of effort into Tasks and committees establishes a quasi-envelope system for the Program as a whole. No one we interviewed in the delivery process review suggested that the relative balance of effort among Tasks was seriously amiss. There were comments to the effect that some Tasks needed more money and some less, but when asked how much money might be moved, the amounts mentioned were almost always less than two percent of the overall funding for PERD.

Probably the most important method for adjusting focus and balance is the constant shifting which goes on as programs and projects are completed and new ones contemplated. To an outsider there may seem to be little change in the R&D funded by PERD because many of the program titles (e.g. Offshore Geotechnics) remain the same year after year. While the titles remain the same, however, the work carried out under the title changes considerably from year to year. Indeed, at the end of a three to four year cycle there may be a one hundred percent change in project work. The continuous change "at the margin" is real and considerable. More rapid change is feasible when projects are smaller and of a shorter duration. However, even larger program areas exhibit considerable change over time.

From year to year the largest amount of change occurs at the project level. Programs change more slowly, as one would expect. Because change at the project level is going on almost continuously, it is important that committees have mechanisms to select from a large number of potential projects (even if not all projects appear at the committee). The main mechanism for establishing committee level priorities has to be some method for client involvement, such as workshops. By definition all projects have a client, or clients, and their involvement in the setting of priorities within committees is a key element in creating priorities which ultimately lead to the most appropriate focus and balance at the committee level and possibly even for a Task.

Task reviews are appropriate mechanisms for helping to ensure the appropriate focus and balance of a Task. For example, as a result of the recent review of the Alternative Transportation Fuels Task (Task 5), the Task will be gradually reducing the resources

devoted to work on fossil fuels and increasing work on true alternatives to gasoline and diesel fuel. Task management is also considering how the Task can increase the proportion of the R&D devoted to longer term, higher risk projects, as well as the proportion of the projects devoted to energy use as opposed to energy production.

Methods to Ensure Quality

There are several methods in place which have an effect on the quality of the research work which is carried out. Because of the applied nature of the research and development activity, its quality can, in many instances, be measured by gains in energy savings, or its use by clients (e.g., to develop regulations), or its contribution to the environment (e.g., reduction of emissions). Simply put, one measure of the quality of PERD funded research and development is its utility.

Almost all of the case studies for the delivery process review show that most committees have a priority setting process of some type (workshops, comments from clients, advisory committees, industry involvement and so on). They also have a reasonable process of discussion about what projects to work on and why. Within departments working on PERD projects, there is a healthy debate about the relevance of the work to the objectives of the Panel and to the departmental mission and a debate usually among scientists or researchers about the quality of the work. This debate also extends to the committees the study team attended, where there were discussions and debate about priorities, level of effort, quality of work, scientific merit, feasibility and the appropriate deliverables. Most, not all, committees have more projects than can be funded and many proposals do not make it to the committee stage because they are turned down within a department before they reach the committee.

The review process varies in intensity and quality across committees. The one addition to the process which has been thought about and was considered by the study team is the addition of outside peer reviewers to the process. To some extent this already occurs because clients and others involved in the current process qualify as peers and would likely be amongst those selected for a peer review process. To go beyond what already exists would require a peer review process similar to that of the National Research Council or a granting council. This could be done, but it would make an already complex process more cumbersome, and it is not clear what additional benefits would be available. To some extent a slight change to the existing committee structure would help (i.e., the addition of an appropriate external expert who is not a client and not a recipient of PERD funds), although this raises its own problems.

Methods to Ensure Incrementality and Complementarity

Through our interviews and our observations of the program committees it became clear that many factors are used at various points in the process to decide on the value of a project, and a number of these relate to the issue of incrementality. These include:

- the research that other parties are doing in closely related areas
- the degree of likely "payoff" from the research to other parties
- for government mission research, the relation of the proposed research to departmental mandates and priorities
- the appropriateness of PERD support and the added value/benefits to the Panel's objectives from supporting the research
- the degree of leveraging that can be obtained
- the interests of clients, including the possible contributions of clients.

From our observations we concluded that at least some factors related to incrementality are generally considered. However the one thing that is missing is a mechanism to ensure that project incrementality is explicitly addressed.

Methods to Ensure Cost-Effectiveness

There are several methods used in the delivery process which contribute to the cost-effectiveness of research. On the cost side, there are consultations within departments and, where several parties are involved, discussions about appropriate costs and how the costs of a project should be shared. Because PERD funds have the effect of levering departmental resources (dollars and people), the costs of projects are carefully scrutinized. For similar reasons the costs of partnered research are also carefully reviewed. This process has intensified as the government has reduced the operating funds available to departments.

Interviews conducted as part of the review of the delivery process cannot easily address the question of the "effectiveness" side of the cost-effectiveness equation. However, it is clear from interviewer comments that the more closely the intended client is involved in the process of project definition and selection, the more likely the project will be cost-effective. Indeed, the only serious potential for ineffectiveness (i.e., a project being carried out at excessive cost over an unduly long period of time or not having an impact commensurate

with its cost) is where clients have not been identified for the work. The methods for ensuring cost-effectiveness are in place and are adequate.

7.6 Methods for Monitoring Progress

As identified above, the frequency of the departmental meetings varies across all departments, anywhere from once a year to four times a year. Most departments indicated that the reporting varies with the type of research. The following represents some of the other mechanisms that exist to manage the progress of R&D.

- Some programs within a Task organize special steering committees to review the research. People invited to sit on the steering committees have specific expertise in the relevant area of research.

- As well as the committee reviews, some departments ask for written updates from researchers anywhere from monthly to four times a year.

- Special workshops are held to discuss issues that have occurred during the research.

- Some programs have a specific reporting system that keeps a "score sheet" on costs and benefits (i.e., energy savings, waste reductions, investments, etc.).

- The progress of each project is measured against the required deliverables by the program committee.

- Due to the geographic location of some of the research labs (e.g., the Bedford Institute of Oceanography), many external parties and institutions (i.e., universities, other research labs) are involved in reviewing the progress of the work within the institutes as a part of their internal review mechanisms.

From our observation of the work of the committees and from the interviews carried out for review of the delivery process we have concluded that the number of methods in place to monitor progress are more than adequate. As noted above, there are a number of review points, and projects are discussed by the whole committee at the annual meeting. This review is a serious one since projects can have their funding delayed, reduced, increased or cut completely depending on how the work is progressing. Because PERD monies are either contracts for work or work done by a scientist in a government laboratory, all of the Government of Canada's usual review and control mechanisms on the dispersal of funds and employee performance also apply to PERD. These ongoing regular elements of the review process coupled to the committee process result in a thorough review of progress.

Methods for Dissemination and Technology Transfer

In the delivery process interviews, researchers and research managers expressed the opinion that the methods used for disseminating results works well. They indicated that their target audience for specific projects was always informed of, and in fact sometimes involved in, the projects and their results. It should be noted that in many cases these target audiences have good reasons (essentially their own self interest) to keep on top of progress.

A special exercise was carried out as part of the delivery process review to attempt to find seven PERD "deliverables", as if for a public request for information. Almost all of the deliverables were easily found, either in the departmental library, or by being referred to the appropriate section, group, or projects personnel. There is some confusion when a title does not imply 1) the origin (which department), 2) whether it is a costed publication, and 3) the nature of the deliverable (proceedings, article within a publication, departmental report, internal or external materials, etc.). Only the helpfulness of staff makes it possible to deal with the apparent inconsistency of materials classification, location and handling. For example, if a publication has a price, it is distributed by the Department of Supply and Services; however, non-priced publications are distributed by the departmental publication centre. On the other hand, internal reports can be in any number of places, ranging from the library to the records centre, to a researcher's file drawer.

As a corollary to this additional exercise, researchers were asked whether their project's products and/or publications were patented or under copyright, and whether they were considered intellectual property. Many of the responses showed some uncertainty about intellectual property rights when applied to government-funded or government-owned products, mainly because many PERD products are in the "public domain". Those who appeared most knowledgeable about these issues were those whose projects involved cooperative ventures with the private or academic sectors. In general, these project researchers did not have much information about intellectual property, copyright, and patents.

It did become clear in the evaluation study -- both as a result of the delivery process interviews and other parts of the study, such as the industry/sector interviews -- that PERD itself is not well known, even by people who are familiar with specific research projects and programs. One thing that Panel could consider would be a cental "marketing" office responsible for "repackaging" and coordinating available deliverables and for channelling public requests. In addition to making project information more widely known and more easily accessible, this office would serve to heighten the profile of PERD, and would maintain contacts with libraries and publications groups in those departments involved in the Program.

We conclude that, in general, the methods used in PERD for disseminating results to the intended clients and effecting technology transfer are adequate. The Panel could implement measures that would increase the awareness of information that is available from PERD projects (and, at the same time, raise the profile of the Program). The effectiveness of technology transfer may be able to be increased by more involvement of clients in the planning phase of projects.

Flexibility of the Delivery Process

The delivery process for PERD is complex and operates at several different levels. Higher level objectives are refined and altered, if necessary, when the whole program is the subject of a submission to Cabinet. The Panel in turn can respond to changes by altering the relationship among Tasks, creating new Tasks or reallocating within and between Tasks.

Discussion about internal departmental capacities and their links to PERD takes place within departments and within the committees, in OERD, and to some extent at Panel meetings. In practice, a department will only undertake a project if it is relevant to the departmental mandate and to the Panel's objectives. Thus the consideration of departmental capacity is built into the actual decision to be involved in a PERD project.

Based on the interviews and our review of the delivery process, the process is sufficiently flexible and rational to respond to changing priorities. Some evidence for this comes not from interviews but the very fact that large and small changes are going on all the time (e.g., reallocations among Tasks and changes in the composition of projects and topics studied).

Program Modifications and Alternatives

The main conclusion of this part of the review exercise is that modifications should be made to the delivery process, but alternative methods of delivery are not attractive. Before introducing possible modifications, we should discuss the question of alternatives.

The alternatives could include: 1) establishing the Panel as something similar to a granting council; 2) transferring R&D funds permanently to departments and; 3) conducting all work from within one department (presumably EMR). The last two alternatives are essentially variants of each other. Alternatives 2 and 3 are unattractive for two reasons. First, their implementation would negate the very reason for creating the Panel process -- to coordinate the federal government response to energy R&D issues, where this response necessarily involves many departments. Secondly, no one department has the necessary expertise to direct an energy research and development program on its own. For these reasons alternate delivery mechanisms which eliminate the inter-departmental aspect of the Panel process are not attractive. It is the fact of the availability of resources through the Panel process which makes departments willing and perhaps eager participants.

Establishing the Panel on a basis similar to that of a granting council has a number of potentially attractive elements. First, it would allow the Panel to be slightly removed from the immediate pressure of inter-departmental politics. Second, it would make it easier to attract other players (e.g., universities and possibly provinces) to the process. Thirdly, it would remove the immediate pressure of any ministerial involvement. Fourth, it might allow for more precise accountability by clearly separating PERD funds from departmental funds. Finally, it would give a visible measure of independence and objectivity to the process.

There are two arguments that can be made against such a change. The first has to do with one of timing. Given the fractious nature of the debate between and among provinces about almost all topics, such a move would likely generate a debate (about federal-provincial responsibilities for example) which would be divisive and do little to encourage the work of the Panel. The second objection is equally important. It is not clear how a council established to carry out work similar to the Panel could/would maintain its links to necessary aspects of government priority setting exercises. Accordingly, this alternative does not seem attractive at this time, although it probably should be investigated more closely.

On balance, the delivery mechanism is appropriate; however, some improvements would enhance the delivery of the Program. In general, the committees should operate as committees in which the members see themselves as agents of the Panel. Properly functioning committees are vital to the success of the delivery of the Program. It is only in the committees that the priorities established by the Panel and the needs of clients can be considered against actual research proposals.

7.0 PROGRAM IMPACTS

ISSUES

1) For the longer term research that has been carried out under the Program, has the research led to important results that have contributed to meeting the Program objectives?

2) For the near-term R&D, how were the results used and what was their impact?

3) What has the Program accomplished in relation to each of its four objectives bearing in mind that some of these objectives are relatively new.

4) What have been the relative impacts and benefits of the individual Tasks?

FINDINGS

1) The really long-term research is found in Task 3, which supports the National Fusion Program (NFP). This work was found to be highly focused on important research topics; of high quality; well-integrated and complementary with other fusion R&D worldwide; addressing topics of importance for probably the next five years (past which it is difficult to predict the research directions worldwide); and having led to significant industrial spin-offs.

2) The near-term R&D has had significant impacts for a large proportion of users. The research has improved the breadth, detail, "science" content, and understanding of technical and other issues related to product and regulatory development.

3) The individual Tasks have all had significant impacts -- none is a "loser".

4) Eighty-two percent of user survey respondents thought the projects they were reviewing addressed very important or moderately important user needs. In general, PERD projects were said to supply better information than users could get on their own -- scientific and technical information and understanding, background data, feasibility studies, testing, and identification of opportunities and constraints.

5) Very few projects were irrelevant to user organizations.

6) Few programs within PERD have high proportions of "unpopular" projects. Only 4% of projects were deemed irrelevant by more than 50% of their reviewers in the user survey, and no program had 50% or more of its projects deemed irrelevant by a similar proportion of reviewers.

7) From most useful to least useful, the general types of use of these projects were:
   i) general information and reference;
   ii) input to the users' own R&D;
   iii) recommendations or decisions regarding government regulations or policies;
   iv investment decisions; and
   v) modifying the user organizations' operational procedures.

8) Overall, the majority (62%) of individual projects were cited by one or more respondents in the user survey as having been highly used or useful to date. Almost three-quarters (73%) of the projects were found either highly useful so far or likely to be highly useful in the future.

9) If the projects they were reviewing had not existed,57% of users felt that it would have been very or moderately harmful for user organizations. Without PERD, respondents noted at least some similar R&D would have been carried out, but some

of it would not have been done at all; significant components of it would have been neglected or done more poorly; the scientific and technical component would have been lacking or poorer; fewer economic benefits would have been achieved; the "Canadian perspective" would be missing; and there would have been a significant time delay before other parties picked up the R&D.

10) If the resources for their projects had been doubled, the majority (65%) of the user survey respondents thought this would have been moderately to very beneficial for the user organizations. The most common impacts cited were: more R&D on topics currently underfunded; more "science" in the R&D; a broader perspective, and on more topics; and a quicker time scale and better efficiency.

11) Forty percent of respondents with an opinion thought there had already been major economic benefits from the R&D, and most of those with an opinion (47% overall didn't know) believed results from one or more projects in their package had already been commercialized.

12) The future usefulness of the projects was generally rated as higher than their present usefulness. It therefore appears that some of the projects are still too new to have been highly useful.

13) Eighty-three percent of the respondents in the industry/sector interviewers said the research in the specific program addressed moderately high or very high priority topics to industry.

14) These interviewees also outlined several economic and non-economic benefits to industry due to PERD. Three types of economic benefits were specified by approximately half the respondents: increased efficiency, cost savings, and increased competitiveness.

15) The most important non-economic benefit was PERD's impact on increasing the degree of networking and coordination among different parties involved in energy R&D.

16) Canada's participation in the R&D Program of the International Energy Agency has produced significant benefits for Canada's energy R&D effort that are well in excess of the costs of participation. This is particularly true of participation in collaborative R&D projects and participation in workshops and conferences.

DISCUSSION

User survey results

The reader is reminded of the methodology for the user survey: packages of project descriptions describing R&D on a single topic or closely related topics were sent to users of the R&D or to experts in the field. Some questions on the survey form asked for comments on individual projects; each reviewer could then comment on one or more projects in his/her package as appropriate, and according to familiarity with each project in the set. During the analysis, results of comments on these packages were aggregated up to the program and Task level.

Focus on general topics of interest to reviewers

Overall, 61% of the respondents indicated that the general subject area of the research programs were of "high interest" to their organizations.

Seventy-eight percent of the respondents overall indicated that their organizations were actively monitoring the R&D being carried out worldwide in the subject area of the research program under review, and 63% said their organizations actively carry out R&D in those same subject areas.

Overall, about 75% of respondents thought that industry would be the most likely user of the research projects they reviewed, while 36% thought government would be the greatest user. This corresponds very well with data from the classification exercise found in Section 5, in which about 67% of individual projects were seen to be mainly directed towards industry and 33% mainly directed towards government.

Addressing user needs

Open-ended responses to this question regarding specific overall ways in which user organizations benefitted from the research can be categorized as the projects supplying:

- Background data: including surveys, feasibility studies, identification of opportunities and constraints, and testing and database services.
- Better understanding of technical processes and scientific matters.
- Development of important new products or processes.
- Better economics.
- Environmental benefits.
- Regulatory and policy information, and appropriate responses to this information.
- Information and research regarding long-term needs.

- Better quality, information dissemination, and additional resources than users could manage alone.

Clearly, better technical and scientific information, plus better (or unique) background information were the most common benefits to users.

Present usefulness

The projects reviewed were most highly rated as a source of general information or for reference purposes. 86% of respondents overall rated them as "highly useful" or "moderately useful". Almost as valuable was the projects' usefulness as a basis for recommendations or decisions by users regarding government regulations or policies: 29% and 35% or respondents rated this as "highly useful" or "moderately useful".

Overall, these results make sense given that the R&D is still, on average, mid-way between fundamental and product development and thus is more likely to be used for informational purposes than operational ones.

It is important to note that a project need not address the needs of a large number of users in order to be considered important or successful. Some R&D may be extremely valuable even if it only concerns the needs of a single user organization if those needs are important enough. It was clearly beyond the scope of this (or any conceivable) evaluation study to review PERD R&D on a project-by-project basis; the case studies, however, give good examples of the type of work undertaken.

Impact of less or more PERD funding

In order to have a further indication of the usefulness and importance of the R&D carried out in the Program, respondents were asked two hypothetical questions: "If the specified research program had never existed, how harmful would this be for [user organizations]?"; and, "If the specified research program has supported twice as much R&D as it did, how beneficial would this have been for [user organizations]?"

Of respondents having an opinion (about 4% were not able to answer this question), Exhibit 8.10 demonstrates that 57% thought the absence of the program would have been "very harmful" or "moderately harmful" for user organizations, and 43% thought it would have been "slightly" or "not at all" harmful.The most common open-ended comments regarding the reasons why the Panel and PERD's absence would be harmful were generally categorized as follows:

- The R&D would simply not have been done at all, or significant and necessary components of it would not have been done or not done well.
- The public sector needs to this kind of research, as the private sector doesn't have the interest, skill, or resources.
- The scientific and technical component would have been lacking or poorer.
- There would be a negative impact on improving the economics of the product/process (either through lacking improved technology or access to new markets).
- The Canadian perspective would be missing.
- The Panel would no longer coordinate industry, government, and consultants.
- There would have been a significant time delay if other parties had to do the R&D.

These results generally support other data on the topic of incrementality; in which we conclude that only about 20% of the projects are likely to have been partly carried out without PERD, and even those would show notable qualitative changes (due primarily to the lack of the PERD portion of the project funding).

In terms of the second question (the benefits of twice as much R&D), about 65% of respondents thought that there would be "very beneficial" or "moderately beneficial" impacts to users if PERD had supported twice as much R&D as it did.

The open-ended comments as to why such increased support would have created "very beneficial" or "moderately beneficial" impacts were generally as follows:

- Generally, the topics in the research program simply need more R&D done on them.
- The time scale of the work would have been significantly reduced.
- There would have been better, more efficient, and quicker product development.
- Local conditions could have been addressed.
- Riskier topics could have been studied.

Economic benefits

Economic benefits, of course, are to be hoped for from much of PERD-sponsored work. About 29% of respondents thought that some projects in their package had resulted in major economic benefits for some sector of the Canadian energy industry, 44% did not think so, and 27% did not know. Of the 77% of respondents with an opinion, about 40% thought there had been major economic benefits from the Program.

The types of specific economic benefits noted for individual projects were generally concerned with better efficiency, cost savings, profit margin, etc., with about 40% of the respondents supplying open-ended responses mentioning this factor; explicit product/service development (also about 40% of respondents); and less common items such as better understanding of technical and scientific processes, more credibility in the marketplace, and better background material being available regarding technical feasibility and marketing opportunities (all less than 10% of respondents).

Finally, 32% of respondents said that results of one or more projects in their package had already been commercialized, while 21% said they had not, and 47% did not know.

Future usefulness

Respondents were asked to rate the anticipated future usefulness of the results of the research projects. With only three exceptions the future usefulness was rated as higher than the usefulness to date, both by factor and by Task.

The three exceptions were: (1) that the projects' input to the user organizations' own R&D was equally rated for past and likely future usefulness for Task 1: Efficiency; (2) the projects' usefulness as a basis for recommendations or decisions regarding government policies or regulations was also equally rated for past and future for Task 1; and (3) for Task 5: Alternative Fuels, that same factor was very slightly lower-rated for the future than the past.

Ninety-three percent of respondents indicated the project results would be highly or moderately useful in the future for general information and reference. The greatest shift to future project usefulness is for projects that are used as input to changing the user organizations' operational procedures.

Results from other Data Sources

There were several questions dealing with the benefits of PERD R&D for industry in the interviews of industry officials and sector experts. First, interviewees were asked: "Does the

R&D carried out in the specific program [they were commenting on] address high priority topics within the industry's own R&D programs?" (This question was only asked of interviewees who had previously stated that the industry sector toward which the specific program is oriented is involved in carrying out R&D.) Their responses were:

Yes - very high priority	30% of reviewers
Yes - moderately high priority	53% of reviewers
No, but the topics are important to industry	13% of reviewers
No, the topics aren't important to industry	3% of reviewers

In elaborating on their responses the most common theme was that the reason PERD addresses high priority topics for industry was that the PERD mechanism has brought about a high level of good cooperation and coordination between government and industry.

Respondents were then asked: "What direct economic benefits have been realized by industry as a result of the R&D carried out in the specific program?" All respondents but one answered that the Program had some kind of economic benefit for their industry.

The main examples given of economic benefits were in increased efficiency -- e.g., heightened efficiency of hog boilers resulting in savings of up to $1 million per boiler -- and cost savings -- e.g., better weather forecasting and better understanding of navigable arctic waters resulting in less shutdown time and less loss of oil and gas production. Other respondents cited increased quality of the product or process leading to greater markets, increased output, enhancement of corollary industries, prevention of problems, and the ability to hold the line on product prices thereby increasing competitiveness.

Finally, industry/sector interviewees were asked: "What other types of benefits have been realized by industry as a result of PERD's involvement in energy related research?" The majority of the interviewees (31) responded that PERD had other types of benefits for their industry (in addition to economic benefits); including the impact of PERD on increasing the degree of networking and coordination among different individuals and parties involved in energy R&D. This benefit was considered very significant by respondents, and some respondents said it was the major benefit of PERD. Many respondents praised PERD for leading to more cooperative efforts, both on the Canadian scene and internationally. The ability to participate in world-wide information exchanges and the ability to take part in collaborative research efforts with government regulators were each cited a number of times. Respondents' comments also indicated a strong appreciation of PERD for sharing the risk in energy R&D. This has allowed industry to undertake riskier, longer term, broader R&D. It has also enabled small firms to get involved in research.

Task 3 : Fusion R&D

Introduction

A modified peer review of the National Fusion Program (NFP). This particular review was conducted because of the highly specialized, international and long-term nature of the R&D of this Task, and because of the scale of the two main projects (the Canadian Fusion Fuels Technology Project (CFFTP) and the Centre canadien de fusion magnetique (CCFM)).

The NFP undertakes work that is of a very long-term nature. Although there are many short-term products that result from the R&D (e.g., knowledge about the behaviour of materials under very high temperatures), there is not likely to be a workable fusion reactor for another two decades at least. For these projects, we wish to know whether the research carried out has already led -- or is likely to lead -- to important results that have contributed to meeting the Panel's priorities. The evaluation question about the importance of the work can then be summed up as:

- Are the topics being addressed by the CFFTP and the CCFM of real importance to fusion research? That is, are they topics that are vitally important to the eventual production to power derived from fusion or, alternately, are they in areas of minor importance to the fusion community?

We investigated five aspects of importance:

- The importance of the NFP research topics to the world fusion effort.
- The quality and productivity of the work. (If they are not high, it does not matter if the topics are important.)
- The complementarity of the R&D with that of other research programs worldwide.
- The likely future importance of the research.
- The significance of any commercial or research spin-offs of the work.

Note that asking whether the topics are important ones is not the same thing as asking whether the results are critically important to the world fusion effort: since Canada spends only about 1% of the worldwide fusion expenditure, the Canadian results cannot reasonably be expected to have a huge impact. The best one could hope for is that the topics are indeed important ones, and that the results obtained in the relatively modest Canadian effort have an impact on world research that is at least in proportion to the scale of Canada's program.

Canadian Fusion Fuels Technology Project (CFFTP)

The impression of the CFFTP project is that its international Advisory Committee has been almost embarrassingly favourable towards the approach of the CFFTP research programs, finding that the Canadian program has made a small but significant contribution to international fusion research. The technology contribution has been perceived as excellent and it has been very well received by the fusion community. The Advisory Committee strongly endorsed this view. Some individual points made by the Committee are noted below.

- One advantage of the CFFTP internationally is the perception -- rightly or wrongly -- that the Canadian tritium capability is "clean": many people prefer to access capability that is not founded upon military research, and thus prefer Canadian to U.S. tritium technology.

- A very important feature of the CFFTP is its links to industry, universities, and national labs. Canada incorporates more input from these sources than any other country and the industrial links in particular create strong advantages for Canadian technology (e.g., increased design efficiency). Canada also offers much more capability through consulting services than do other countries.

- The CFFTP is offering the first and only non-university tritium handling course in the world. Its approach is imaginative and useful, providing the kind of hands-on experience that previously had to be learned on-the-job at reactor sites.

- The Committee felt that it should be said that, while the quality and professionalism of the CFFTP work is very high. In the future several of the other research organizations are planning expansions and improvements to their facilities, and the relative size and importance of the Canadian effort may thus diminish. To counter this, Canada may be able to draw on the type of "partner funding" (contribution from Ontario Hydro and other contractors) that it has successfully used in the past and which is not a feature of other international research efforts, all of which rely solely on government support.

Centre canadien de fusion magnetique (CCFM)

The international Advisory Committee for the CCFM noted that the Tokamak de Varennes (TdeV) was a relatively new facility that is devoted to leading edge research into both physics issues and specific fusion technologies. As such it is somewhat difficult to assess what the eventual importance of the TdeV's approach to fusion technology might be, since no one knows yet what will work and what won't. The role of the TdeV is to provide

information on particular physics and technical subjects which may be incorporated into other machines attempting to "break even" (i.e., produce as much energy from fusion as is used to create the fusion reaction). The TdeV does not itself attempt to break even.

Committee review

Overall, the Committee had absolutely no concern about the focus of the CCFM, believing that the thrust of the program was absolutely correct: the types of physics and technologies focused upon by the TdeV are indeed important in the context of world fusion research. The TdeV has developed diagnostic equipment that is second to none in the world for a facility of its size, and in the process has contributed to setting standards for such diagnostics.

The reactor has been designed to be very flexible in terms of topics addressed. This is aided by its relatively small scale and provides the ability to switch to different technologies as research points the way to more promising topics. The small scale allows inexpensive modifications: ten TdeV reactors could be built for the cost of one substantial modification to the Joint European Torus (JET). As budget cutbacks in other countries force the closure of many small research reactors, the importance of the TdeV increases.

Due to its access to Hydro Quebec's large power grid (and access to the proper power node) the reactor can do the kind of long pulse studies that are now considered to be important. This grid access is not unique to the TdeV, nor was it the first to have it, but rather this machine was part of the experimental process that showed such access to be important.

There will be a need for skilled people to build and run ITER. The TdeV will provide good training on a relevant machine and will be useful for developing long-range technical capability. In order to create the ability to eventually receive successful fusion technology local input during the development phase is very important: the TdeV is seen as a very important part of that input.

For the future, the Committee believed the TdeV would remain important for at least the next five years. Past that is impossible to judge at this time. Of key importance is the focus of the machine upon work for ITER: essentially the whole CCFM program will be "imbedded" in ITER tasks -- properly, in the Committee's opinion.

Having the CCFM approach ITER work from a slightly different perspective should be valuable. In the international fusion effort, only four other machines will be using the same technologies used at Varennes, and because of the large size of these others they may not as easily pursue the "physics" topics as can the TdeV.

Conclusions

The NFP has made a strong and continuing effort focus on technologies that will be of critical importance to future working reactors:

- tritium technologies: tritium will be a critical fuel component in the first operational reactors; and

- aspects of tokamak design: at this point, tokamaks are the design of choice for likely practical reactors.

Virtually all of the research topics addressed by the two major fusion projects are focused upon these areas, and individual components of the Canadian projects were rated as being either "high" or "very high" in importance in relation to world fusion efforts. Both projects carefully gear their work to be relevant to the needs of the International Thermonuclear Experimental Reactor (ITER), a $5 billion development reactor which will be the next step towards finalizing practical fusion designs.

Additionally, the NFP has taken the tack of choosing from within these broad areas only specific topics in which Canadian industry already had, or could readily develop, unique niche specialties. This approach appears to have been eminently successful so far, as the international community finds the Canadian projects to be unique in their blend of scientific and industrial capability, high in scientific quality, and having a significance greater than their budgets would otherwise suggest.

In the future, there are clear indications that world effort will grow substantially. Some of this increase will be in areas directly competitive with the Canadian R&D: much larger tritium facilities, for instance, are already being planned in several countries. Also, the participants in the fusion rationale workshop believed that as fusion moves away from research and into engineering, we will almost certainly see diminished international cooperation and a return to a strongly competitive world market in fusion technologies. Given that Canadian research only comprises about 1% of the international fusion budget, an active and ongoing effort will be needed to ensure that the domestic effort is not swamped. This will have to concentrate both on maintaining the domestic scientific competitiveness in critical fusion areas, and on actively assuring that technology transfer to industry indeed occurs, with fusion and non-fusion markets vigorously identified and pursued.

Task 7: International Coordination

The bulk of the funds in Task 7 are devoted to Canada's participation in the R&D program of the International Energy Agency (IEA).

Canada, as a member of the OECD, has participated in the IEA since its foundation. Through PERD, Canada has been an active participant in the IEA's Committee on Research and Development (CRD) through its presence at the tables of the various committees and working parties (the Canadian delegate held the chairmanship of the CRD over the 1986 to 1989 period), through its participation in many of the CRD-sponsored conferences and workshops (including organizer and host for some of these events), and through its involvement in 54 percent (or 27) of the implementing agreements and 50% (or 83) of the R&D projects sponsored by the IEA between 1975 and 1990. Canada has been particularly active in pursuing projects in the renewable energy and end-use technology areas, where 64 projects have been initiated to date. Canada is presently involved in 35 of the 75 projects which are ongoing at the IEA.

Between 1985/86 and 1989/90, PERD contributed approximately $3.5 million toward the funding of specific IEA implementing agreements and projects. Some of the largest contributions have been directed toward research in the areas of coal and heat pump systems, representing two-thirds of this total funding. However, these formal financial contributions represent only a partial picture of the total value of PERD's contribution to IEA-sponsored R&D as many projects are conducted on a task-shared basis, or have task-shared elements, whereby EMR and other participating federal government departments and agencies provide personnel and associated expenses for conducting the required research or for undertaking other related activities in support of IEA projects.

While no estimates are available on the total value of the R&D undertaken by the IEA, or the total value which is contributed by PERD, individual project cost data suggest that Canada, on average, contributes approximately eight to 20 percent of total direct costs of the projects it is involved in. Canada's contribution can vary substantially depending on the nature of the project. Overall, Canada is providing slightly less than its proportionate share if funding were evenly split among member countries, while having access to R&D valued at several times its contribution.

Findings from other reviews of the IEA collaborative research program reveal that member countries have gained substantial benefits from the collaborative process, especially the smaller country members who have relatively limited energy R&D capability. Canada, with its modest size domestic R&D program, has gained considerable benefits from its participation in this multilateral R&D program. Co-funding of IEA related research projects

has been a relatively inexpensive means of leveraging Canada's own research program and for gaining access to R&D valued at several times Canada's investment.

Some other examples of benefits resulting from collaborative projects that were reviewed in this study are described below.

- The development of comprehensive technical data sets for accessing useful and relevant data and information in a timely, detailed and cost-effective fashion.
- The demonstration of international R&D efforts and techniques to Canada.
- The opportunity to demonstrate Canadian expertise and capabilities to an international audience was also viewed as having significant tangible and intangible benefits.
- The opportunity to compare Canadian capabilities and technologies to those of other participating countries has resulted in the improvement of Canadian capabilities, techniques and technology development strategies.

Several other forms of benefits were also noted by the researchers interviewed, such as the acceleration of the application of R&D results in the district heating, coal burners, and bioenergy technology areas; the development of new products and more efficient production levels in the coal combustion and fusion areas; and the contribution to international standards development in the fields of alternative motor fuels and building ventilation.

In general, the project reviews carried out in this study suggest that the international collaborative process has been of much benefit to Canada in broadening and enhancing its domestic R&D program and in expanding its technology development and exploitation capabilities. Collaborative opportunities which promote access to proprietary and detailed data sets and which facilitate information exchange are some of the key mechanisms in which Canadian research capabilities and technologies can be improved upon or developed.

Two other forms of IEA participation that were reviewed in this study were participation in IEA committees and working parties and participation in conferences and workshops.

Canada is viewed by the IEA as an active participant in each of the committees and working parties of the CRD. In fact, IEA officials who were interviewed referred to Canada as an "outstanding country" in terms of our participation. Canadian representatives, however, do not regard this participation as having resulted in major benefits for Canada. The effective functioning of these bodies has been constrained by political and bureaucratic imperatives, and over the last five years or so meetings have become very procedure-oriented, with limited attention directed toward developing strategies to guide the international collaborative

process. (There are indications that some progress is now being made to address these problems).

Many of the participants in IEA conferences and workshops who were interviewed described them as useful and essential mechanisms for carrying out Canada's own research program in a meaningful way. As in the case of collaborative research projects, conferences and workshops are another forum for sharing research information, results and techniques and for identifying new technology opportunities. The cost involved in sending researchers to these conferences/workshops was viewed as minimal when considering the millions of dollars of international research which is accessible to Canadian researchers to review and question in a timely manner.

Several participants also stressed the value of networking and informal contacts brought about by these conferences/workshops. Activities occurring beyond the formal IEA conference were often of more consequence in informing the participants of research being done in their fields than the formal papers presented. It was noted that conversations with peers provide the information which papers leave out. Many of the conference/workshop participants indicated that a loss of access to these events would result in a loss of access to valuable information regarding energy research worldwide. This loss of information would affect the advice given to the government regarding energy-related issues as well as result in the duplication of research done elsewhere in the world.

In summary, our review concluded that while Canada's involvement in the research program of the IEA is basically mandatory because we are a member country of the OECD and the IEA, it is quite obvious that our membership produces real, specific benefits to Canada's energy R&D effort. PERD, as the conduit for Canada's participation, has been an appropriate linkage for involving Canadian energy researchers in IEA international projects.

8.0 INVOLVEMENT Of OTHER PARTIES

Issues

1. What has been the extent of cost recovery?

2. What has been the extent of contracting out?

3. To what extent has the R&D involved partnership arrangements and joint projects with other parties?

4. To what extent has the Program promoted increased energy R&D by other parties?

5. What has been the extent of gross leveraging, where gross leveraging is defined as the amount of resources from other parties in support of PERD R&D. What has been the extent of net leveraging, where net leveraging is defined as the amount of such resources that would not have been devoted to these projects in the absence of the Program.

6. How does current performance on topics (1) through (5) compare to what could optimally be accomplished?

Findings

1. **Cost Recovery.** Overall levels of cost recovery have been about 1% of PERD funding, or 0.5% of total resources (i.e., including PERD, A-base, and other funding), from 1985/86 through 1989/90.

2. **Contracting Out.** About 79% of PERD funding, or 36% of total resources, are devoted to contracting out.

3. **Joint Agreements and Partnership Agreements.** About 80% of projects reviewed had some type of such arrangement (of which 66% were formal arrangements).

4. **Increased energy R&D by other parties.** About 38% of the user survey respondents felt PERD had influenced user organizations to increase their energy-related R&D. Of those believing such a change had taken place, the energy R&D budgets were estimated by respondents to have increased by 44% due to PERD. In addition, 48% of respondents thought PERD had influenced the type or subject area of the R&D. Industry officials and sector experts agreed: 80% thought an energy-related R&D increase by users could be attributed to PERD.

5. **Leveraging.** Gross leveraging (see definition in list of issues) over 1985/86 through 1989/90 has averaged 119% of PERD funding. Net leveraging has been 42% of gross leveraging. That is, 42% of the gross leveraging can be attributed to a real impact of the Program on leveraging R&D funds, whereas 58% of it represents R&D resources that would have been spent by departments and industry anyway, even in the Program's absence. The net leveraging is therefore 50% of PERD funding (119% x 42%). In other words, for every $1.00 PERD spends, it levers $0.50 additional R&D funds that would not otherwise have been spent. Leveraging of departmental PYs may be even more significant than leveraging of funds.

Discussion

This section presents evidence from two main sources: for descriptions of current levels of contracting out, cost recovery, and leveraging, it relies on analysis of the database of PERD projects; for the analysis of what the optimal levels of extramural performance should be, on interviews of a sample of 62 PERD research managers. Other data sources are mentioned as appropriate. Where Total resources are discussed, the totals include PERD funding, A-base (including salaries and O&M), private cash and in-kind contributions, and other (e.g., crown corporations' contributions).

Cost Recovery

We are defining cost recovery to be revenues returned to the Receiver General Canada through mechanisms such as fees for service, licensing, and royalties. It does not include cost-sharing by contractors, in-kind donations, and so forth.

The level of cost recovery has been very low: about 1.16% of PERD funds or 0.53% of total project funds were recovered in 1985/86 through 1989/90.

It should be emphasized that this evaluation covered the 1985/86 - 1989/90 period, and there was relatively little emphasis on cost recovery by government research organizations for much of this period. Also, the nature of much PERD-supported R&D is not service-oriented and hence not amenable to cost recovery.

There are two major ways of generating cost recovery: through fees for service (e.g., when government laboratories provide testing facilities to the private sector), and through licensing and royalty fees arising from the development of new technology.

There is a clear indication, however, that there is movement towards exploring the possibility of achieving more cost recovery, both on the government's part and on the part of individual managers. While several managers stated that they have only recently begun to focus on recovering costs, approximately half felt that there were future opportunities for increasing the amount of it for projects in their research area. Generally, this movement towards cost recovery may be simplified as technology matures from the research stage to the applied stage. This can not only be attributed to the maturing of a particular technology but also to the lag between development and market application of a new technology.

Many respondents felt that cost recovery strategies were not always easy to implement. It was stated that the basic tools and resources needed to pursue cost recovery were not available. With no mechanism in place to assist them managers have difficulty not only in having the time but also in having the skills to properly market their products.

In addition, the present system provided the researchers with little incentive to promote or market their results to achieve cost recovery. The benefits from any recovery go directly to the Receiver General and not necessarily back into the same department, much less the same project or project area.

Approximately one quarter of the project managers had some concerns about increasing the current levels of cost recovery. This emphasis on cost recovery would shift the research focus away from fundamental long-term work towards applied short-term work. It was stated that a balance between long-term and short-term research needs to be maintained to ensure that scientific freedom is not stifled. A strong case was made for the public sector's function being that of taking risks industry cannot afford to do and then disseminating this information to the general public.

The possible recovery of costs from basic research that becomes the foundation for a new product, application or even field, sometimes is not realised for a significant period of time. This situation, combined with the subject area of much of the research and the fact that many researchers are just now thinking in terms of cost recovery, explains to a large extent the low levels of this activity. Overall, because of the low levels of cost recovery now occurring it is too soon for managers to know what the optimal level should be.

Contracting Out

Description

Overall, about 36% of Program research funds were contracted out. The rationale for contracting out was generally qualified on a project to project basis. Most commonly it was because in many cases there were no in-house facilities to do the research, and thus contracting out was the only way to accomplish it. Other managers mentioned the goal of getting the best researchers in the field to do the work. In some situations contracting out had been appropriate in the particular project discussed but was not necessarily normal department policy. Managers also stated that they contracted out because they did not have the funding to hire additional in-house support.

Overall, managers were pleased with whatever situation they were in: about 88% of the respondents expressed general satisfaction about their contracting out arrangements. There was no difference in satisfaction depending on whether the project supported government or industry goals. Most of those currently dissatisfied with contracting out levels in fact already did little of it and wanted to do even less.

About 64% of the project managers said that they did not see any opportunities for increasing the level of contracting out. In fact, in 28% of the sample projects contracting out was

already at 100%. The reasoning for this varied. Some managers were in a situation in which they had unique facilities and/or technical support that could not be found in the private sector. Other respondents said they would prefer more in-house help or a stronger basis of expertise within the department, as well as more flexibility to follow up on interesting topics.

Occasionally managers commented on the difficulties of contracting out itself. These centred on high project costs because of the contractor's need to make a profit, the difficulty of coordinating many small contractors, and the arms' length nature of the control managers had when the R&D was not done in-house. The requirement to put every project to be contracted out to tender was found to be a frustrating bureaucratic process, especially when the project was either small or there was only one contractor that had the necessary capabilities to do the particular job. In these situations the researchers found that it was tedious and expensive to go through the tender process and DSS.

Partnerships and Joint Ventures

Approximately 80% of the projects reviewed involved some form of cooperation with industry, other federal government agencies, provincial governments, universities and/or international arrangements; 66% of which were formal joint arrangements. In all of the projects where there was cooperation, the most common partner was industry (52%), whether it was a formal or informal agreement. In most situations there was more than one partner. Federal departments, other provinces and universities all participated to approximately the same extent in all cooperative projects. In two projects, the consultants contributed financially to the projects and in one other project there was an international partner.

Most of the respondents (90%) considered their cooperative arrangements to be satisfactory; most frequently, in fact, project managers were quite enthusiastic about their arrangements. Several respondents felt that this was the best way they could have done their work. They cited the enormous amounts of in-kind support they received, sometimes representing hundreds of thousands or even millions of dollars worth of support. Other managers found that industry would supply facilities and services already in place that were invaluable to the research, giving them an effective way to "stretch" their funds. Without the sharing of costs and the in-kind support, several projects could never have begun.

Another advantage to joint arrangements mentioned was that cooperation ensured that a larger group of parties had access to the information, thus speeding up the transfer of technology.

There was a clear indication that the appropriate types and numbers of joint arrangements could only be assessed on a case by case basis and an optimal level was impossible to identify. Nevertheless, these results indicate that acceptable levels can be quite high indeed, and there is relatively little room for expanding these arrangements, except perhaps in the area of licensing arrangements. Any increase in these, however, would necessitate a review of cost recovery issues.

A few project managers expressed serious concern over the new emphasis on cooperative arrangements. These respondents felt that research should be scientifically driven. The emphasis on joint arrangements had turned past cooperation into a bureaucratic exercise. This push for implementation was seen as doing a disservice to research. Industry was seen as often having mixed motivation and a lack of research and development funding. (This was especially so with smaller firms with less capital and in new areas of research.)

In conclusion, there was abundant support for joint ventures. While the appropriate level of cooperation needed to be assessed on a case by case basis, in many situations cooperation was considered necessary. Even at the initial stages of research, joint arrangements were often considered to be vital. Not only did they provide cost sharing but they also allowed for all parties to participate in the establishment of research criteria.

Promoting Additional Energy R&D by Other Parties

The user survey revealed that about 38% of respondents (26% of users, and 58% of experts) felt that PERD had influenced user organizations to increase the resources devoted to energy-related R&D. Those who believed such an impact had occurred estimated that user's R&D budgets had increased on average 44%. In addition, 48% of respondents thought the type or subject area of users' R&D had changed through the Program's influence.

Eighty percent of the industry officials and sector experts felt that PERD had influenced organizations to increase their energy-related R&D.

Using the same methodology used for the calculation of incrementality, we estimate that for 72% of PERD projects (included in the user survey), the spending of other (non-PERD) parties on these projects was greater than it would have been if PERD had not existed. PERD has, therefore, had a significant influence on increasing the energy R&D spending by these parties, at least on these particular projects.

Leveraging

Leveraging refers to the ability of PERD research managers to obtain non-PERD resources for their projects. These resources encompass A-base funding from the individual line

departments (including the salaries, O&M, capital, and contributions), funds from other parties (e.g., contractors who cost-share or partners in joint ventures), and in-kind contributions of the private sector. (Note that line staff in the departments would refer to the PERD funds as being leveraged by their department.)

The total of these other (non-PERD) funds is the value of "gross leveraging". PERD funds are used to lever resources equal to 118% of the PERD support overall. Overall gross leveraging has shown a steady rise over the past five years, from 102% of PERD funding in 85/86, to 122% in 87/88, and up to 140% in 89/90.

The table below breaks out the private sector component of overall gross leveraging. Private sector contributions consist of both funds and in-kind contributions. Note that in-kind contributions may be valued in two quite different ways: (1) by the additional costs incurred

Table 6

Gross Leveraging:
Sum from 1985/86 to 1989/90

Source of Funds	TOTAL $000s
PERD	417,692
A-Base	162,966
Other (Private cash, in-kind and other)	332,002
Total resources	**912,660**
Gross Leveraging	
Non-PERD	494,968
% of PERD	118.50
% of Total	54.23

by the contributor (these may be relatively low, as in the case of DFO using "ships of opportunity" to do oceanographic work: the incremental costs to the shipowner may be almost zero); and (2) by the amount PERD would have otherwise had to pay for the services or products contributed (the cost of renting ship time to do the same oceanographic study might be very high.) The respondents to the project information questionnaire were allowed to choose the method they felt was most appropriate.

"Net leveraging" refers to gross leveraging minus the amount of non-PERD resources that would have been devoted to the projects anyway even in the absence of PERD. Calculations were done for three classes of projects:

(1) Projects in the user survey which would not have existed without the Program (according to user survey respondents): for these, gross and net leveraging are the same, and equal the non-PERD contributions.

(2) Projects in the user survey which would have existed without the Program: for these, the net leveraging figure is equal to the amount that would not have been contributed by non-PERD sources in the absence of the Program. The user survey data was used on a project-by-project basis to calculate this.

(3) Projects not in the user survey. For these, a project-by-project review was done by the evaluation study team to estimate what would likely have been contributed in the absence of PERD. Data from the case studies was used as appropriate, as many of these projects (e.g., IERD, or the fusion projects) were the subjects of more detailed reviews. Separate net leveraging figures were calculated for A-base resources, and for industry and other resources.

The final figure summed from 85/86 through 89/90 was:

Table 7

PERD Leveraging 1985/86 to 1989/90

	$000
• Projects in category 1):	$119,777
• Projects in category 2):	20,522
• Projects in category 3):	67,430
TOTAL	$207,729

Comparing this figure of about $208 million to the total non-PERD resources of about $495 million found in TABLE 6 indicates that net leveraging is about 42% of gross leveraging. In other words, about 42% of the total leveraged funds can be attributed to the real leveraging impact of the Program, but 58% would have been spent anyway.

Leveraging of resources can also, of course, include leveraging of PYs. We have examples from two departments:

- In 1988/89 DFO's energy-related R&D was supported by a total of 59 PYs. Of these 9 (15%) were supported by the PERD funding, 46 (78%) were supported by (or levered from) DFO, and 4 (7%) were supported by other funding such as NSERC and the UP fund. Put another way, nine PERD-supported PYs levered another 50 PYs of DFO and other support (a leveraging factor of about 550%).

- In 1988/89 EC's energy-related research was carried out by 15 PYs supported by PERD, and 49 PYs supported by the department (a leveraging factor of about 330%).

These examples indicate that from the department's viewpoint the PYs levered from them by PERD is probably more significant than the funding levered.

While 75% of research managers indicated that the level of leveraging of project funds was currently satisfactory, many of the managers (even those now satisfied) simply wished they had more money. Several expressed the wish that the additional money come from A-base funds within their department so that they might have more control of priorities and goals of A-base-funded research, the research would be regarded as more important by their departments, and the funding would probably be more stable and long-term.

There is some evidence that the amount of A-base funding the Program is currently leveraging from other departments in support of PERD projects is close to the maximum that could reasonably be expected. In the interviews of departmental officials all the officials (for whom the question was applicable) stated that:

- PERD has had an effect on the allocation of departmental resources for R&D in their department/agency.

- There have been R&D projects to which their department/agency has devoted resources and to which it would not have devoted resources if PERD had not existed.

They were then asked: "Roughly what percentage of your department's/agency's total R&D budget has been devoted to such projects?" The answers averaged 11%.
This seems to us to be a fairly high percentage, given that these departments regard their

own R&D budgets as extremely tight. It would appear that the current amount of leveraging of departmental R&D funds caused by PERD is currently distorting the R&D priorities of these departments to some extent. This is one indication that it would probably be difficult to obtain much greater departmental funding for PERD projects than presently exists.

This conclusion was reinforced by the officials' responses to the question: "Has PERD support had any negative impacts on your department/agency?" The most common response was that it had skewed the department's own research priorities. (Given the positive comments about PERD, those departments would much rather have PERD funds than not.)

Other evidence supporting this conclusion can be found in various program evaluations that have been carried out by the individual departments. It is clear from a number of the evaluation studies reviewed during the evaluation assessment for this study that there is some resentment in participating departments of the fact that the availability of PERD funds "forces" them to carry out R&D on topics they would not select on their own and makes many of their scientists dependent on this "soft" money.

Conclusions

While it is difficult to generalize about the involvement of other parties due to the differing circumstances of each project, it can be said that a general effort has been made to expand industry's role in R&D, although the incidence of this expansion in the form of cost recovery, contracting out, joint arrangements, or the leveraging of funds has differed widely.

An interesting point that was made about cost recovery, joint arrangement and contracting out was their interrelatedness. Several managers considered joint ventures to be equivalent to contracting out in situations where industry not only contributed financially to the project but also performed the work (a fairly common situation). In the analysis presented in this report, this situation was considered a joint arrangement, but it does indicate that any policies concerning either of the two will likely have a significant effect on the other. The same can be said of cost recovery: some managers considered any sort of cost sharing (as in a joint arrangement) as cost recovery as well. Although this is not so (and was not treated as such in this analysis), strategies such as restructuring patent rights would possibly have a significant effect on any cost sharing schemes.

ANNEX A

RESPONSE TO THE RECOMMENDATIONS OF THE PERD EVALUATION

Since the completion of the Evaluation, there have been several changes in the way in which government and EMR operate. The recognized need to reduce overhead within government and the need to improve processes have been considerations in the development of the response to the recommendations of ARA. In addition, the growing emphasis on PS-2000, the move of Departments to single operating budgets, and the emergence of the Total Quality Management concept have all influenced the responses outlined below.

There are several recommendations within the evaluation that have been addressed already, and others that can be responded to at this time. A number relate to the delivery and operational aspects of the Program. The response to these has been developed in the form of a set of revised operating processes for the Panel. A revised set of guidelines, or the PERD Process Handbook, was tabled at the 61th meeting of the Panel held March 27, 1992. At that meeting Panel members decided that they wanted further consultation on these new operational procedures before their implementation. Consultations will take place over the summer 1992, with a revised process being in place by the fall. At that time a definitive response to the evaluation can be made.

EVALUATION RECOMMENDATION	RESPONSE
There were a few programs or sub-programs identified during the review of program rationale which should be looked at further with regard to either their degree of support for current government energy policies or their consistency with current government science policies.	In the main, individual PERD programs were found to be valid elements of federal energy strategy, and generally supported overall federal policy objectives. Under the proposed PERD Operating Handbook, consistency with federal energy and other policy objectives will be more visible in the project approval process.
A detailed review should be undertaken of: • the technology transfer mechanisms of the National Fusion Program • future mechanisms, strategies, and resources required to take advantage of ITER industrial opportunities.	Continuation of the incremental fusion R&D program will address these issues. However, the continuation of this program within PERD must be a matter for greater review and discussion with Ministers.

The Panel should consider altering the current 70/30 balance between R&D on energy production and energy usage and increase the emphasis on issues related to usage.	At the 60st meeting of the Panel on Energy R&D, members approved the creation of a strategic planning function for the Program to be part of OERD. The work of this group will include an on-going assessment of the focus and balance of PERD.
If there were a significant decrease in program resources (which, in our opinion, could not be justified on the basis of the evaluation findings), consideration should be given to significantly reducing the amount of Program funding that is devoted to fossil fuels, and in particular, to oil and gas (frontier and bitumen/heavy oil resources).	The recent approval of the Program for the next 5 years did not alter funding. Responding to this recommendation is not, therefore necessary.
The Panel should consider the establishment of a new committee to focus additional work on the elaboration of future energy strategies and scenarios.	Instead of introducing a new committee to the operation of the Panel, OERD will provide the strategic direction and analysis for the Panel. This work will be based on EMR's own forecasts of future energy demand and supply scenarios.
It is the view of the study team that a properly functioning committee is the crucial link to the success of the delivery of the PERD Program. The primary role of the committee should be to develop and recommend an optimum scientific program for the financial envelope established by the Panel, taking account of the strategic and operational priorities of PERD. To strengthen the committee process, membership should include: • representatives from more than one department; • involved clients; and • external government participants .	Agreed. To be addressed within the new PERD Process Handbook.

The Panel should communicate strategic and operational requirements to the Task (i.e. committee chairs within a Task), and the chairs should, after discussion and reflection, communicate the priorities to the committees. This process should take account of the existing planning process in government and agencies and be cognizant of the existence of external advisory committees who should at a minimum be aware of PERD, Task and committee priorities.	Agreed. To be addressed within the new PERD Process Handbook.
The Panel should encourage, where applicable, mechanisms which encourage competition for projects within committees. A necessary step is to establish mechanisms which free up resources so that new projects can be funded.	Agreed. To be addressed within the new PERD Process Handbook.
To enhance the competitive process the Panel should strengthen its mechanisms for allocating and re-allocating funds within the Program (i.e., among committees and between Tasks).	Agreed. To be addressed within the new PERD Process Handbook.
The Panel should review its reporting and monitoring requirements. The purpose of this is to enhance the monitoring and on-going evaluation of projects and the work of the Program as a whole.	Agreed. To be addressed within the new PERD Process Handbook.
The Panel and OERD should investigate the costs and benefits of a more pro-active communication and dissemination process to a wider audience.	Agreed to at the 60th Panel meeting. In progress.

As Secretariat to the Panel, OERD should review its existing procedures to see how they might be revised to support the above recommendations. In particular the benefits of a standard set of summary pages with specific headings for key criteria such as energy savings, economic benefits, clients, project incrementality, and so on, should be examined.	Agreed. Addressed by the new PERD Process Handbook.
As the most direct link with committees, the OERD should strengthen its ability to make the committee process an effective one. Committee work (especially that of the Chair) is already onerous, and acceptance of these recommendations would make it more so.	Agreed. To be addressed within the new PERD Process Handbook.
OERD should act as a facilitator to the committees within each Task so that the Task priorities can be established and communicated to the program committees.	Agreed. To be addressed within the new PERD Process Handbook.
Tasks and committees should be chaired by people who can devote the necessary time to committee work.	Agreed. To be addressed within the new PERD Process Handbook.
Committee chairs should ensue that a priority setting mechanism which involves clients is in place, and is used by the committee in communicating priorities and deciding on projects to support.	Agreed. To be addressed within the new PERD Process Handbook.
Committee chairs should be responsible for ensuring that the membership is appropriate (e.g., balanced with the right technical experts) and that the members are present for the discussion or consulted if they are unable to attend.	Agreed. To be addressed within the new PERD Process Handbook.

As part of the committee process, OERD should ensure projects are reviewed by the appropriate people (e.g., scientists, clients, outside experts). A coordinated effort by the OERD representative and the Chair of the program would be suitable.	Agreed. To be addressed within the new PERD Process Handbook.
There should be a standard format for summary information about a project.	Agreed. To be addressed within the new PERD Process Handbook.
The summary should specify expected benefits for the project (e.g., energy, economic, and environmental benefits).	Agreed. To be addressed within the new PERD Process Handbook.
OERD should circulate to committee members and involved researchers an explanation of how to calculate and present benefits (e.g., energy, economic, and environmental benefits).	OERD staff to undertake rather that burdening Departments.
Each project should have a unique identifier.	Agreed. To be addressed within the new PERD Process Handbook.
PERD should establish a formal evaluation and review cycle and plan. Specifically: • the database of PERD projects should be maintained in a more organized fashion. • basic descriptive information should be collected annually for all PERD projects -- project objectives, description of the work carried out, description of the main accomplishments, non-PERD resources (A-base, private, other), amount of contracting out, and amount of cost recovery. • a plan should be prepared for the periodic review and evaluation of different components of PERD.	An accountability framework has been developed to assist on-going monitoring and evaluation. This will be included in the revised PERD Process Handbook.